UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NEW ENGLAND - REGION I
1 CONGRESS STREET, SUITE 1100 (HBT)
BOSTON, MASSACHUSETTS 02114-2023

September 27, 2007

Donald C. Morris, P.E.
Environmental Director, Civil Engineering
Hanscom Air Force Base
66 SPTG/CEV
Hanscom AFB, MA 01731

Re: ***Five-Year Review (2003-2007), Hanscom Air Force Base, Bedford, Concord, Lexington, and Lincoln, Massachusetts***

Dear Mr. Morris:

This office is in receipt of the Air Force's *Five-Year Review Report, Hanscom Air Force Base* dated August 2007. Upon review of this report, EPA concurs with the findings that all remedies which have been implemented are currently protective of human health and the environment.

This third five-year review was triggered by the second 5-year review completed in 2002. Consistent with Section 121(c) of CERCLA and EPA's *Comprehensive Five-Year Review Guidance (OSWER Directive 9355.7-03B-P)*, the next statutorily required five-year review must be finalized by September 30, 2012.

Sincerely,

James T. Owens III, Director
Office of Site Remediation and Restoration

cc. Mary Sanderson/EPA
Bryan Olson/EPA
Matthew Audet/EPA
Garry Waldek/MassDEP

Five-Year Review Report

Third Five-Year Review Report

for

Hanscom Field/Hanscom Air Force Base Superfund Site

Bedford, Concord, Lexington, Lincoln

Middlesex County, Massachusetts

August 2007

PREPARED BY:

66th Mission Support Group/Civil Engineering
Hanscom Air Force Base, Massachusetts

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Hanscom Air Force Base, Massachusetts

Approved by: **Date:**

Thomas J. Schluckebier

14 Sep 07

THOMAS J. SCHLUCKEBIER
Colonel, USAF
Commander
66th Air Base Wing

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Five-Year Review Report

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List of Acronyms

1,2-DCE	1,2-dichloroethene
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ARAR	Applicable or Relevant and Appropriate Requirement
AST	Aboveground Storage Tank
BIW	Boundary Interceptor Well
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cfs	Cubic feet per second
cis	cis-1,2-dichloroethene
CoC	Contaminant of Concern
CoE	U.S. Army Corps of Engineers
DEA	Debris Excavation Area
DD	Decision Document
DNAPL	Dense Non-Aqueous Phase Liquid
DoD	Department of Defense
ESC	Electronic Systems Center
EWRA	East Wetland Remediation Area
FAA	Federal Aviation Administration
FS	Feasibility Study
GAC	Granular Activated Carbon
GC	Gas Chromatograph
gpm	gallons per minute
H&A	Haley & Aldrich, Inc.
HI	Hazard Index
IC	Institutional Controls
IROD	Interim Record of Decision
IRP	Installation Restoration Program
IW	Interceptor Well
LNAPL	Light Non-Aqueous Phase Liquid
LTM	Long Term Monitoring
LUC	Land Use Controls
MA DEP	Massachusetts Department of Environmental Protection
Massport	Massachusetts Port Authority
MCL	Maximum Contaminant Level

List of Acronyms – Continued

MCLG	Maximum Contaminant Level Goals
MCP	Massachusetts Contingency Plan
mgd	million gallons per day
MSL	mean sea level
NCP	National Oil and Hazardous Substances Contingency Plan
NFRAP	No Further Response Action Planned
NPL	National Priorities List
O&M	Operation and Maintenance
O,M&M	Operation, Maintenance and Monitoring
ORC	Oxygen Release Compound
OSRR	Office of Site Remediation and Restoration
OU	Operable Unit
OW	Observation Well
PAH	Polynuclear Aromatic Hydrocarbon
ppb	Parts per billion
ppm	Parts per million
PSG	Professional Services Group, Inc.
RA	Remedial Action
RAB	Restoration Advisory Board
RAO	Remedial Action Objectives
RAO (MCP)	Response Action Outcome
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SCADA	Supervisory control and data acquisition system
SVE	Soil Vapor Extraction
SVOC	Semi-volatile organic compound
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbon
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VER	Vapor Enhanced Recovery
VOC	Volatile organic compound
WWRA	West Wetland Remediation Area

Executive Summary

This is the Third Five-Year Review for the Hanscom Field/Hanscom AFB Superfund Site. A review of in-place remedial actions is required by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) every five years as long as hazardous substances, pollutants, or contaminants remain on site above levels that allow for unlimited use and unrestricted exposure. The triggering action for this review is the date of the Second Five-Year Review Report as shown in EPA's WasteLAN database: September 30, 2002.

The Department of Defense (DoD) initiated its Installation Restoration Program (IRP) concurrently with CERCLA with the overall goal of cleaning up contamination on DoD installations. The USAF began implementing the IRP at Hanscom AFB during the early 1980s with records reviews, interviews and field investigations to identify potentially contaminated sites. Subsequently Hanscom AFB, including Hanscom Field, was listed on the USEPA National Priorities List (NPL) in 1994. Of the 22 individual Hanscom AFB IRP sites with known or suspected contamination, 6 with on-going remedial actions have been designated as CERCLA sites and fall under jurisdiction of the United States Environmental Protection Agency (USEPA) and are the subject of this review. These CERCLA sites were grouped into the following three Operable Units (OUs):

Operable Unit 1

IRP Site 1	Fire Training Area II
IRP Site 2	Paint Waste Disposal Area
IRP Site 3	Jet Fuel Residue/Tank Sludge Disposal Area

Operable Unit 2

IRP Site 4	Sanitary Landfill

Operable Unit 3

IRP Site 6	Landfill/Former Filter Beds
IRP Site 21	Unit 1 Petroleum Release Site

The location of these three Operable Units and the IRP Sites is shown in **Figure 1**.

Pre-NPL Remedial Action Plans for Hanscom Field Sites (IRP Sites 1, 2, 3/5 and 4): In 1985 Haley & Aldrich, Inc. (H&A) was retained to conduct investigations and prepare Remedial Action Plans for IRP Sites 1 through 5 on Hanscom Field. Field investigation of the sites was conducted by H&A in 1985 and 1986. The results of this field work were documented in Appendix F of the report entitled *Installation Restoration Program, Phase IV-A, Hanscom AFB Area I.* Based on the results of the field investigation H&A prepared a "Remedial Action Plan" for each site. Following public review of the plans, Hanscom AFB documented selection of each site's Remedial Action Plan in a *Decision Paper, Area 1 (Sites 1-5)* dated April 6, 1988. This

Decision Paper was approved by the Base Commander on April 20, 1988. Please note that the Remedial Action Plan entitled IRP Sites 3/5 noted that "... field investigations have failed to indicate that fire training activities or any contamination associated with those activities can be attributed to Site 5." Subsequently a Decision *Document for Close-Out* for Site 5 was signed by the Base Commander on 27 September 1991. This Decision Document included the determination "... that there is no basis for the existence of this site" and included the declaration that "... the selected remedy is no action and the site is hereby closed-out." Regulatory confirmation of the close out of IRP Site 5 was later documented in the *Interim Record of Decision, Operable Unit 1* dated November 2000.

The Remedial Action Plans for IRP Sites 1, 2 and 3 included the removal of drums and/or visibly contaminated soil in 1988; construction of a groundwater collection, treatment and recharge system which commenced operation in 1991; and a long term groundwater and surface water monitoring program. The groundwater collection system included collection trenches at each of the three sites and four (4) boundary interceptor wells along the Hanscom Field/Hanscom AFB northern property boundary with the Town of Bedford's property. The purpose of these wells is to intercept any contamination migrating off the airfield complex through the lower/glacial till and/or bedrock aquifers.

The Remedial Action Plan for IRP Site 4, the former Hanscom AFB municipal landfill, included a low permeable cap, drainage measures and a compensatory wetland, Construction of this remedy was completed in 1988 and long-term monitoring program conducted between December 1989 and September 1992.

Post-NPL Actions

OU-1/IRP Sites 1, 2 & 3: Following designation of Hanscom Field/Hanscom AFB as a NPL site, USEPA became the lead regulatory agency and IRP Sites 1, 2 and 3 which are located on Hanscom Field were grouped into Operable Unit 1 to facilitate further response actions. These three sites are confirmed groundwater contamination source areas. Contaminants of Concern (CoCs) at OU-1 consist of chlorinated and aromatic volatile organic compounds (VOCs) and the VOCs with the highest concentrations are trichloroethene (TCE), 1,2-dichlorothene (1,2-DCE) and vinyl chloride. Dense non-aqueous phase liquid (DNAPL) is known to be present at Site 1 and is suspected to be present in other areas within OU-1. While the extent of the DNAPL is not fully known it is believe to be fully contained and within the capture zone of the existing collection system. This conclusion is supported by long-term monitoring data which has found dissolved-phase contaminant concentrations in groundwater which are indicative of nearby DNAPL only in monitoring wells up-gradient of the existing collection system.

> **IRP Site 1**: This site is located at the north end of the airfield was reportedly used from the late 1960s through 1973 for fire training exercises. It is situated in the town of Bedford. Two (2) burn pits were used at this site. Waste oils, solvents, paint thinners, and degreasers were collected from around the base, dumped into pits, ignited, and then

extinguished. Occasionally, aircraft wrecks and fuselages were burned in the pits. The size of each of the two pits was estimated to be 15 feet by 20 feet. There is no information indicating that a liner or containment was used at these pits.

IRP Site 2: This site located in the northeast portion of the airfield, was used for disposing of waste solvents and paint from 1966 to 1972. It is situated in the town of Bedford. Metal plating wastes may also have been disposed in this area from the early 1960s through 1972. During the 1988 removal action four (4) drum burial pits of various sizes were found and excavated. There is no information indicating whether any type of liner or containment was used at these pits.

IRP Site 3: This site located in a triangular area in the western portion of the airfield bounded by Taxiway "Whiskey" to the north, Taxiway "Mike" to the southwest and Runway 5-23 to the southeast. It is situated in the town of Concord. According to the IRP Phase I Records Search, several hundred drums of waste oils and paint wastes were buried at the Jet Fuel Residue Area during the period of 1959 to 1969. Disposal at the Tank Sludge Area, which is located within the same triangular area and to the northwest of the Jet Fuel Residue Area, reportedly occurred during the early 1960's. Because of the close proximity of this site to the Jet Fuel Residue Area, they were discussed and evaluated as one site. During the 1988 removal action ten (10) drum burial pits of various sizes were found and excavated. There is no information indicating whether any type of liner or containment was used at these pits.

As stated above, Remedial Action Plans for IRP Sites 1, 2 and 3 were developed and implemented prior to the NPL designation. Subsequently, in 1995, USEPA advised that additional studies were necessary to ensure that these earlier actions fully addressed CERCLA requirements. Using the results of all previous investigations a *Final Ecological Risk Assessment, OU1* (dated January 1999) and a *Focused Feasibility Study, OU1* (dated May 2000) were completed. This effort included groundwater flow and solute transport models, and an evaluation of the soil-to-groundwater contaminant transport pathway for human health risk assessment. Based on these reports and the presence of DNAPL in the bedrock fractures, the Project Team concluded that it was not prudent to select a final remedy at that time since there was a moderate to high degree of uncertainty regarding attainment of Applicable or Relevant and Appropriate Requirements (ARARs) within all of the OU-1 area. At that time it was determined that an Interim Record of Decision (IROD) would be appropriate and an *Interim Proposed Plan for Hanscom AFB Operable Unit 1* (dated June 2000) was prepared. The public review of this plan, to include a Public Information Meeting and Public Hearing on June 28, 2000, was completed in July 2000 without comment.

Subsequently an Interim Record of Decision, dated November 2000, selecting an interim remedy for OU1 was signed by the Air Force on January 24, 2001 and by USEPA on February 6, 2001. The Commonwealth of Massachusetts formally concurred with this IROD by letter dated December 27, 2000. The selected interim remedial action for cleaning up OU-1/IRP Sites 1, 2

and 3 included continued operation of the existing dynamic groundwater remediation system, implementation of institutional controls, and monitoring of groundwater and surface water. This course of action was selected to provide time to collect additional information to support a final remedy.

The assessment of the Second Five-Year Review completed in 2002 found that the remedy at OU-1/IRP Sites 1, 2 and 3 was protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks were being controlled.

A recommendation of the Second Five-Year Review was to continue on-going efforts to gathered information to support a final OU-1 remedy that will be targeted at remediating all or part of the groundwater plume. In this regards significant progress has been made (since the IROD was issued in 2000) towards the cleanup of OU-1 and additional information has been gathered which supports the selection of a final remedy. Therefore, in 2007, a Focused Groundwater Flow and Transport Model (May 2007), a Revised Focused Feasibility Study of OU-1 (May 2007), and a Proposed Plan (May 2007) were prepared to support a Final Record of Decision (ROD) for OU-1. The public comment period for the OU-1 Proposed Plan was from June 8, 2007 to July 9, 2007. In addition, a public meeting and a public hearing were conducted on June 20, 2007 in Bedford, MA to discuss the OU-1 Proposed Plan and to accept oral comments. No written comments were received during the comment period, including the public hearing. During the public hearing on June 20, 2007 oral comments were accepted from the public. Comments received during the hearing were positive and no required no changes to the Proposed Plan. Based on the above a ROD selecting the final remedy for OU-1 has been prepared and is currently being staffed for regulator concurrence. This final remedy which will be selected by this ROD is the Continued Operation of the Existing Dynamic Groundwater Remediation System, Land Use Controls and Monitoring.

According to the data review, site inspections, and interviews conducted in the summer of 2007 the remedy is functioning as intended by the IROD/pending ROD and there have been no changes in the physical conditions of the site that could affect the protectiveness of the remedy. All threats at the site have been addressed through physical measures and land use controls and there is no other information that calls into question the protectiveness of the remedy. The OU-1 RA has been, and continues to be, successful in containing/capturing the groundwater contamination at the Hanscom Field boundary with the Hartwell Town Forest and the Jordan Recreation Area and in cleaning up both the on-site and off-site surface water and groundwater. Current data also indicates that contaminant concentrations in the source areas, the on-site plumes, and the off-site plume are declining. As a result the assessment of this, the Third, Five-Year Review finds that the **remedy** for OU-1/IRP Sites 1, 2 and 3 **is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.**

OU-2/IRP Site 4: IRP Site 4 was used as the Hanscom AFB municipal waste landfill from December 1964 until December 1974. The site covers 10.5 acres and is located approximately

1,800 feet southeast of the approach end of Runway 5-23 on Hanscom Field. The landfill is situated predominantly in the town of Lincoln, with a small portion protruding into the bordering town of Concord. Pre-1964 topographic maps of the area indicate that the site was a wetland area associated with Elm Brook. During its active life, the landfill was intended to be primarily for the disposal of solid waste. However, the IRP Phase I – Records Search report states that interviews with Base personnel confirmed that dumpsters containing waste from all shops and research laboratories were emptied into the landfill during its 10-year operation. No attempt was made to segregate hazardous materials from non-hazardous materials. The landfill ranges from 10 to 15 feet deep and is estimated to have a volume of 210,000 cubic yards. As discussed above the remedial action constructed in 1988 placed an impervious cap over the area. The area is also bermed with drainage ditches to channel runoff from the capped area to the wetlands. Today the area is grassed open space with a softball field in the southern half.

Following the listing of Hanscom Field/Hanscom AFB on the NPL, USEPA requested that CERCLA Human Health and Ecological Risk Assessments, to include Supplemental Sampling and Analysis, be completed for IRP Site 4. The site was also designated Operable Unit 2 at this time. The additional monitoring was conducted and the CERCLA risk assessments were completed. Subsequently USEPA determined that the Remedial Action completed in 1988 was acceptable as a final remedial action. The Project Team (Remedial Project Managers for Hanscom AFB, USEPA & MA DEP) concluded that additional long-term groundwater monitoring data was not required but, since the landfill waste remains on-site, Five-Year Reviews of the remedial action were appropriate.

USEPA and Hanscom AFB completed a site inspection in May 1997 and USEPA issued *Five-Year Review Report #1, Hanscom Air Force Base Superfund Site, Middlesex County, Massachusetts* dated September 1997. This review concluded "based on the field inspection, and human health and ecological risk assessment, protectiveness of the landfill cap at Site 4 has been demonstrated" however, the review did identify a requirement to remove scrub brush growing in the drainage ditches and on sections of the cap and berms and for a long-term inspection/ maintenance program to be instituted. The field work to remove the scrub brush was completed in the spring of 1998 and a long-term inspection and maintenance program was instituted and continues to the present.

Quarterly inspections between 1998 and 2002 confirmed that there were no changes of any kind that could affect the protectiveness of the remedy and the assessment of the Second Five-Year Review in 2002 was that the remedy at OU-2/IRP Site 4 continued to be protective of human health and the environment. This assessment also found that the recommendations of the 1st Five-Year Review had been implemented and that a long-term inspection and maintenance program was in place to ensure continued protectiveness of the remedy. Subsequently, quarterly inspections since 2002 have found no changes that could affect protectiveness.

According to the data review, site inspections, and interviews conducted in the summer of 2007 the remedy continues to function as intended by the 1988 Remedial Action Plan and there have

been no changes in the physical conditions of the site that could affect the protectiveness of the remedy. A long-term inspection and maintenance program is in place to ensure continued protectiveness of the remedy and all threats at the site have been addressed through physical measures and land use controls. There is no other information that calls into question the protectiveness of the remedy. Therefore the assessment of this, the Third, Five-Year Review finds that the **remedy** for OU-2/IRP Site 4 **continues to be protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.**

OU-3/IRP Site 6: OU-3/IRP Site 6 is approximately 15 acres in area and is located in the northeast portion of Hanscom AFB. It is situated in both the town of Bedford and the town of Lexington. The site is bounded to the north by a former railroad spur, to the northeast by a wetland area and small pond, to the east by a commercial industrial park, to the south by a service road (Hunter Street), and to the west by IRP Site 21 (the former aviation fuel facility). IRP Site 6 consists of three distinct areas: the former filter beds (including the former sludge beds) and two (2) hillside landfill areas; the south landfill (including a suspected ash disposal area and Building 1855 Underground Storage Tank (UST) site); and the west landfill. The former filter bed area is higher than the wetlands to the north and was the location of the original sanitary waste treatment system (used from 1947 until the mid 1950's) for Hanscom AFB. This system, which was abandoned in place when the Base connected to a municipal sanitary waste system, consisted of an Immoff Tank, Dosing Tank, Filter Beds (six (6) sand filled cells with a concrete berm surrounding each cell) and two (2) sludge beds. Following the abandonment of the treatment system, this area became a disposal site for municipal wastes, construction debris, and clean fill. As a result the filter beds were overlain by approximately 5 to 15 feet of solid waste material. Immediately adjacent to, and to the south of the filter bed area are two (2) hillside landfill areas (south and west). Disposal in these two areas was mainly clean fill and/or construction debris. The south landfill was originally graded into terraces, however, these were obliterated by dumping of clean fill from a building foundation excavation and construction debris in the late 80's/early 90's. The southernmost portion of the south landfill includes a suspected ash disposal area and the former location of a 1,000-gallon No. 2 fuel oil UST on the west side of Building 1855. When the UST tank was removed in 1990, evidence of a petroleum release was found. Building 1855 formerly housed an incinerator and is currently a licensed solid waste transfer station for Hanscom AFB.

The Remedial Investigation (RI) of the site was completed in 1998 and Human Health and Ecological Risk Assessments were completed in 1999. The human health risk assessment identified that future industrial site workers could potentially be exposed to CoCs in surface soil. Also, the hypothetical scenario identified that future hypothetical residential groundwater users living in houses built on OU-1 may be exposed to an unacceptable human health risk that exceeds 10-4 (carcinogenic) and HI>1 (noncarcinogenic). Although this is not a likely scenario, it must be considered under the CERCLA regulation, the NCP. In addition, the ecological risk assessment identified an unacceptable risk to soil invertebrates and animals feeding 100% of the time at the landfill areas (especially the suspected Ash Disposal Area), to benthic and water

column organisms in the wetlands, and to the black-crowned night heron from DDT in the wetlands. Based on the RI and risk assessments a *Focused Feasibility Study, Operable Unit 3, Site 6 – Landfill* and a *Proposed Plan for Hanscom AFB Operable Unit 3/Site 6* were prepared. The public review of the Proposed Plan, to include an Information Meeting and Public Hearing on June 20, 2000, was completed in July 2000 without comment. Subsequently, a Record of Decision, dated September 2000, selecting the final remedy for OU3/IRP Site 6 was signed by the Air Force on November 14, 2000 and by USEPA on December 5, 2000. The Commonwealth of Massachusetts formally concurred with this Record of Decision (ROD) by letter dated October 16, 2000.

The construction of the final remedy in accordance with the IRP Site 6 ROD was substantially completed in September 2001 and review of the *Remedial Action Report* confirmed that the remedy was constructed in accordance with the Remedial Design. The remedial action for cleaning up OU-3/IRP Site 6 included containment/pervious capping of three landfill areas, removal of contaminated sediments and landfill debris from adjacent private property and placing of this material within the capped landfill area, long-term monitoring, and institutional controls. In addition, the remedy included establishment of a groundwater compliance boundary and a Contingency Groundwater Remedy in the event monitoring results show that the remedy is not effective in maintaining groundwater quality outside the compliance boundary. Immediately following construction of the remedy a long-term inspection, maintenance and monitoring program commenced to ensure the continued protectiveness of the remedy.

The was only one issue noted in the Second Five-Year Review in 2002 related to current site operations, conditions, or activities that could affect current and/or future protectiveness of any of the Hanscom Field/ Hanscom AFB remedies. This was a discolored liquid seeping from the former filter bed area of OU-3/IRP Site 6 into the wetland remediation areas. This liquid was analyzed during construction of the RA (August 2001) and found to have concentrations of some dissolved metals that exceeded one or more standards. Due to the limited data collected at that time (mid 2002) it was recommended that additional liquid seep monitoring be completed to determine whether or not this condition affected the current or future protectiveness of the OU-3/IRP Site 6 remedy. However, the assessment of the Second (2002) Five-Year review found that the remedy at OU-3/IRP Site 6 was protective of human health and the environment in the short-term because construction had been completed and institutional controls implemented. This assessment also found that in order for the remedy to be protective in the long-term, the following actions were required: additional groundwater, liquid seep and surface water monitoring to confirm that natural flushing and natural attenuation are reducing the size and strength of the contaminant plume within the compliance boundary and that groundwater quality is being met outside the compliance boundary. It was expected that it would take approximately three to five years to collect sufficient data to make a final protectiveness determination.

A Five-Year Monitoring Plan specified by the Remedial Design for the wetland areas remediated during the construction phase of the Site 6 Remedial Action was completed 2006. The Wetland Mitigation Monitoring Reports for this monitoring clearly indicate that the wetlands have

exceeded the design goal for vegetative cover, and provide ample evidence that wildlife habitat has been restored. The Remedial Design also specified that the initial Five-Year Monitoring should be followed by a Long-Term Monitoring Plan for continuing evaluation of the restoration every 5 years. Therefore the next formal monitoring event (an ecosystem evaluation of the restoration areas) will be programmed to be completed in June 2011.

Inspections since 2002 confirm that there have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. The long-term monitoring data indicates that the surface water quality in the adjacent wetlands is not being threatened and that natural flushing and natural attenuation appear to be reducing the size and strength of residual contamination within the landfill area. Current monitoring data also indicate that groundwater outside the groundwater compliance boundary appears to meet MCLs, however, additional data/time is required to confirm that the Site 6 Groundwater Compliance Boundary (which was revised/expanded further to the north in 2006) adequately defines where the dissolved arsenic concentrations are less that the arsenic 10 ug/L MCL. Future groundwater monitoring data will be reviewed by the Project Team as it is collected to assess whether or not changes in the compliance boundary's location, monitoring wells or land use controls/institutional controls are required.

As recommended in the Second Five-Year Review in 2002 the LTM Plan for Site 6 was modified to include the sampling and analysis of the liquid seeping from the northern slope of the former filter bed area landfill. Samples were collected in April 2003, September 2003 and again in October 2004 and were analyzed for all of the Site 6 CoCs. Since there have been no visible seeps. The results of the limited post-RA sampling and analysis of the water seeping from the side slope reflected a water quality that met the AWQC for all constituents except for iron. This iron could be the result of historic Site 6 landfilling actions but is more likely naturally occurring since the Hanscom Field/Hanscom AFB area has a significant amount of iron (as evidence by the iron filing of wells and well pumps which are components of the RA at both OU-1 and OU-3/IRP Site 21). Liquid seeping from the former filter bed area into the wetland remediation areas (WWRA & EWRA) is no longer considered to be a concern/issue since the post-RA seeps are no longer evident.

According to the data review, site inspections, and interviews conducted in the summer of 2007 the remedy is functioning as intended by the ROD for OU-3/IRP Site 6 and there have been no changes in the physical conditions of the site that could affect the protectiveness of the remedy. A long-term inspection and maintenance program is in place to ensure continued protectiveness of the remedy and all threats at the site have been addressed through physical measures and land use controls. There is no other information that calls into question the protectiveness of the remedy. Therefore the assessment of this, the Third, Five-Year Review finds that the **remedy** for OU-3/IRP Site 6 **is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.**

OU-3/IRP Site 21: IRP Site 21 is an area with groundwater contamination and three separate areas of petroleum products floating on the water table. These areas are technically referred to as light non-aqueous phase liquid (LNAPL) pools. The site is approximately 5 acres in area, situated in the town of Bedford in the northeast portion of Hanscom AFB and adjacent to IRP Site 6. IRP Site 21 is the area of a former aviation fueling facility that was used for storage, off-loading, and dispensing of jet fuel and aviation gasoline from at least 1945 through 1973, and to store and distribute No. 2 fuel oil during the early 1970s. Fuel was stored in aboveground and underground storage tanks, which had associated pump houses and a network of underground piping. This area was also used for the storage of cleaning solvents and other petroleum products (oils and lubricants) associated with aircraft and vehicle maintenance.

Since the discovery of IRP Site 21 in 1990, several interim remedial actions have been conducted and the RI and risk assessments were completed in July 2000. Based on these documents and data gathered during the interim remedial actions, a *Feasibility Study, Operable Unit 3/ Site 21* dated June 2001 and a *Proposed Plan for Hanscom AFB Operable Unit 3/Site 21* dated July 2001 were prepared. The public review of the Proposed Plan, to include a Public Information Meeting and Public Hearing on August 1, 2001, was completed in August 2001 without comment. Subsequently, a Record of Decision, dated October 2001 selecting the remedy for OU3/IRP Site 21 was signed by the Air Force on August 20, 2002 and by the USEPA on August 29, 2002. The Commonwealth of Massachusetts formally concurred with this ROD by letter dated January 22, 2002.

The construction of the final remedy in accordance with the IRP Site 21 ROD commenced in June 2003 and was substantially completed in September 2003. The selected remedial action for cleaning up OU-3/IRP Site 21 includes interceptor trenches with passive recovery wells; removal and disposal of petroleum saturated soil encountered during trench construction; enhancement of biodegradation of groundwater contamination by ORC® application in all trenches; a network of ten active recovery wells connected to an existing treatment system; monitoring; land use controls/institutional controls; and groundwater containment/treatment and vacuum enhanced recovery (VER) contingencies. Following construction there was a 6-month shakedown/ assessment period for the 10-well LNALP/groundwater recovery and treatment system which commenced 15-September 2003. Review of the Remedial Action Report confirmed that the remedy was constructed in accordance with the Environmental Cleanup Plan and is being operated in accordance with the Operation and Maintenance Plan.

Immediately following the shakedown/assessment period the long-term operation and maintenance of the 10-well LNALP/groundwater recovery and treatment system commenced. Also the long-term LNAPL and groundwater/surface water monitoring which had commenced prior to the RA has been continued. The post-RA groundwater/surface water monitoring of the site commenced with a baseline monitoring round in October 2003 to identify contaminants of concern in the groundwater water and surface water and to provide a baseline to monitor changes over time in the contaminant concentration levels.

According to the data review, site inspections, and interviews conducted in the summer of 2007 the remedy is functioning as intended by the ROD and there have been no changes in the physical conditions of the site that could affect the protectiveness of the remedy. All threats at the site have been addressed through physical measures and land use controls and there is no other information that calls into question the protectiveness of the remedy. Review of the monthly Remedial Action Reports and Long-Term Monitoring Reports completed to date confirms that progress towards attainment of RAOs is being made, that there is natural containment of the on-site LNAPL and natural containment/ natural attenuation of the on-site groundwater contamination and that water quality of the adjacent Shawsheen River is not being threatened. As a result the assessment of this, the Third, Five-Year Review finds that the **remedy** for OU-3/IRP Site 21 **is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.**

Issues: There are no issues related to current site operations, conditions, or activities that affect current and/or future protectiveness of any of the Hanscom Field/Hanscom AFB remedies.

Recommendations and Follow-up Actions: The following are required and suggested improvements to current site operations, activities, remedies, or conditions. *Hanscom AFB is* responsible for their implementation with regulatory oversight by USEPA Region I and/or MA DEP.

OU-1/IRP Sites 1, 2 and 3: Continue to implement Remedial Process Optimization initiatives as suggested by operational experience, monitoring and the evolution of new applicable remediation technologies to complete the cleanup in the most cost effective and timely manner possible.

OU-2/IRP Site 4: None

OU-3/IRP Site 6:

- Determine whether or not dissolved thallium is a.contaminant of concern in the on-site groundwater,
- Determine whether or not the groundwater compliance boundary is adequately defined by the current network of monitoring wells.

OU-3/IRP Site 21: None

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: **Hanscom Field/Hanscom AFB**		
EPA ID *(from WasteLAN)*: **MA 8570024424**		
Region: I	**State: MA**	**City/County: Bedford/Middlesex**

SITE STATUS	
NPL status: ✠ Final ☐ Deleted ☐ Other (specify)	
Remediation status (choose all that apply): ✠ Under Construction ✠ Operating ✠ Complete	
Multiple OUs?* ✠ YES ☐ NO	**Construction completion date:** Will be date of OU-1 ROD
Has site been put into reuse? ☐ YES ✠ NO	

REVIEW STATUS	
Lead agency: ☐ EPA ☐ State ☐ Tribe ✠ Other Federal Agency – US Air Force	
Author name: Thomas W. Best	
Author title: Installation Restoration Program Manager	**Author affiliation: Hanscom Air Force Base**
Review period:** 2002 to 2007	
Date(s) of site inspection: 07/24/2007	
Type of review: ✠ Post-SARA ☐ NPL-Removal only ☐ NPL State/Tribe-lead	☐ Pre-SARA ☐ Non-NPL Remedial Action Site ☐ Regional Discretion
Review number: ☐ 1 (first) ☐ 2 (second) **X** 3 (third) ☐ Other (specify)	
Triggering action: ☐ Actual RA Onsite Construction at OU #____ ☐ Construction Completion ☐ Other (specify)	☐ Actual RA Start at OU#____ ✠ Previous Five-Year Review Report
Triggering action date *(from WasteLAN)*: 09/30/2002	
Due date *(five years after triggering action date)*: 09/30/2007	

* ["OU" refers to operable unit.]
** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Five-Year Review Summary Form, cont'd.

Issues: There are no issues related to current site operations, conditions, or activities that affect current and/or future protectiveness of any of the Hanscom Field/Hanscom AFB remedies.

Recommendations and Follow-up Actions: The following are required and suggested improvements to current site operations, activities, remedies, or conditions. Hanscom AFB is responsible for their implementation with regulatory oversight by USEPA Region I and/or MA DEP.

OU-1/IRP Sites 1, 2 and 3: Continue to implement Remedial Process Optimization initiatives as suggested by operational experience, monitoring and the evolution of new applicable remediation technologies to complete the cleanup in the most cost effective and timely manner possible.

OU-2/IRP Site 4: None

OU-3/IRP Site 6:

Determine whether or not dissolved thallium is a contaminant of concern in the on-site groundwater,

Determine whether or not the groundwater compliance boundary is adequately defined by the current network of monitoring wells.

OU-3/IRP Site 21: None

Protectiveness Statement(s):

OU-1/IRP Sites 1, 2 & 3: The remedy at OU-1 is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

OU-2/IRP Site 4: The remedy at OU-2 continues to be protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

OU-3/IRP Site 6: The remedy at OU-3/IRP Site 6 is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

OU-3/IRP Site 21: The remedy at OU-3/IRP Site 21 is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

Other Comments: None

Five-Year Review Report

I. Introduction

The United States Air Force has conducted a five-year review of the remedial actions implemented at the Hanscom Field/Hanscom AFB Superfund Site in Bedford, Concord, Lexington and Lincoln, Massachusetts. This is the third five-year review for the Hanscom Field/Hanscom AFB Superfund Site. The triggering action for this review is the date of the Second Five-Year Review Report, as shown in USEPA's WasteLAN database: September 30, 2002. The five-year review is required due to the fact that hazardous substances, pollutants, or contaminants are or will be left on site above levels that allow for unlimited use and unrestricted exposure.

The purpose of five-year reviews is to determine whether the remedies at a site are protective of human health and the environment or are expected to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and recommendations to address them.

The United States Air Force is preparing this five-year review pursuant to CERCLA §121 and the National Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The United States Air Force interpreted this requirement further in the National Contingency Plan (NCP); 40 CFR §300.430(f) (4) (ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

II. Site Chronology

Table 1: Chronology of Site Events

Event	Date
Initial discovery of problem or contamination	
– IRP Sites 4 & 6	5 June 1981
– IRP Site 2 & 3	25 June 1982
– IRP Site 1	April 1983
– IRP Site 21	14 June 1990
Pre-NPL responses	
– Hydrogeologic Investigation of Hanscom Field	June 1982 – September 1984
– Remedial Action Plans for IRP Sites 1 thru 5	September 1985 – May 1988
– Design of IRP Site 1 Soil Removal	December 1986 – August 1987
– Design of IRP Sites 2 & 3 Drum Removal	December 1986 – August 1987
– Design of IRP Site 4 Soil Cap Old Landfill	December 1986 – August 1987
– IRP Phase II-Confirmation/Quantification-Stage 1 for IRP Sites 6 through 13	November 1986 – August 1988
– Design of pump & treat system for Sites 1, 2 & 3	February 1987 – May 1988
– IRP Site 1 Soil Removal	September 1987 – August 1988
– IRP Sites 2 & 3 Soil & Drum Removal	September 1987 – June 1988
– Construction of IRP Site 4 Soil Cap	September 1987 – September 1988
– RI/FS for IRP Sites 6, 8 & 13	September 1987 – June 1992
– Construction of groundwater collection, treatment and recharge system for IRP Sites 1, 2 & 3	September 1988 – January 1991
– Long-term Monitoring of IRP Site 4 (7 Rounds)	November 1989 –November 1992
– Long-term Monitoring of IRP Sites 1, 2 and 3/5	November 1990; February – March 1991; August 1991
– IRP Site 21 Pilot Product Recovery	December 1990 – February 1991
– Operation of groundwater collection, treatment and recharge system for IRP Sites 1, 2 & 3	23 April 1991 - present
– Preliminary RI, IRP Site 21	October 1992 – March 1994
– IRP Site 21 SVE & Groundwater/Product Recovery	March 1993 – December 1993
NPL listing	31 May 1994
Removal Actions - OU-3/IRP Site 21	September 1995 until replaced by final RA 15 September 2003
Remedial Investigation/Feasibility Study completed	
- OU-2/IRP Site 4 Supplemental Sampling	February 1996
- OU-2/IRP Site 4 Risk Assessments	April 1997
- OU-3/IRP Site 6 Supplemental RI	July 1998
- OU-1 Ecological Risk Assessment	January 1999
- OU-3/IRP Site 21 Remedial Investigation	April 1999
- OU-3/IRP Site 6 Risk Assessments	July 1999
- OU-3/IRP Site 6 Focused Feasibility Study	May 2000
- OU-3/IRP Site 6 Proposed Plan	May 2000
- OU-1 Focused Feasibility Study	May 2000
- OU-1 Interim Proposed Plan	June 2000
- OU-3/IRP Site 21 Supp. RI & Risk Assessments	July 2000
- OU-3/IRP Site 21 Feasibility Study	June 2001

Table 1: Chronology of Site Events

Event	Date
- OU-3/IRP Site 21 Proposed Plan - OU-1 Revised Focused Feasibility Study - OU-1 Proposed Plan	July 2001 May 2007 May 2007
ROD signature - OU-3/IRP Site 6 ROD dated September 2000 - OU-1 IROD dated November 2000 - OU-3/IRP Site 21 ROD dated October 2001 - OU-1 ROD dated September 2007	 Air Force - 14 November 2000 EPA - 5 December 2000 Air Force - 24 January 2001 EPA - 6 February 2001 Air Force - 20 August 2002 EPA - 29 August 2002 Air Force – pending EPA - pending
ROD Amendments or ESDs	None
Enforcement documents (CD, AOC, Unilateral AO)	None
Remedial design start – OU-1/IRP Sites 1, 2 & 3 – OU-2/IRP Site 4 – OU-3/IRP Site 6 – OU-3/IRP Site 21	 Pre-NPL Pre-NPL 27 September 1999 3 December 2002
Remedial design complete – OU-1/IRP Sites 1, 2 & 3 – OU-2/IRP Site 4 – OU-3/IRP Site 6 – OU-3/IRP Site 21	 Pre-NPL Pre-NPL 13 April 2001 10 June 2003
Superfund State Contract, Cooperative Agreement, or Federal Facility Agreement signature	None
Construction dates (start, finish) – OU-1/IRP Sites 1, 2 & 3 – OU-2/IRP Site 4 – OU-3/IRP Site 6 – OU-3/IRP Site 21	 Pre-NPL Pre-NPL 29 March 2001 - 17 September 2001 2 June 2003 – 15 September 2003
Construction completion date	Date of pending OU-1 ROD
Actual remedial action start – OU-1/IRP Sites 1, 2 & 3 – OU-2/IRP Site 4 – OU-3/IRP Site 6 – OU-3/IRP Site 21	 Pre-NPL Pre-NPL 18 September 2001 15 September 2003
Final Close-out Report	n/a
Deletion from NPL	n/a
Previous five-year reviews	September 1997, September 2002

III. Background

Physical Characteristics

Hanscom Field/Hanscom AFB is located in the central part of Middlesex County, Massachusetts, approximately 14 miles northwest of downtown Boston and 11.5 miles south of downtown Lowell, Massachusetts. The complex occupies land in the towns of Bedford, Concord, Lexington, and Lincoln (**Figure 1**). Topographically the Hanscom Field/Hanscom AFB area is located in a low-lying basin surrounded by hills. The relatively flat runway portion of Hanscom Field lies in the ancient lake bed of glacial Lake Concord. The ground surface elevation on this former lake bed ranges from 120 to 130 feet above mean sea level (MSL). The hills south of the air base, and Pine Hill to the west, rise to more than 200 feet MSL. Hills north of the airfield area are more subdued, but still rise above 150 feet MSL. Former glacial Lake Concord, and Hanscom AFB on its southern edge, drain to the Shawsheen River, which flows north-northeast from the site to join the Merrimack River approximately 15 miles downstream. The topography and surficial geology of the Hanscom Field/Hanscom AFB area is illustrated in **Figure 2**.

The Department of Defense (DoD) initiated its Installation Restoration Program (IRP) concurrently with CERCLA with the overall goal of cleaning up contamination on DoD installations. The USAF began implementing the IRP at Hanscom AFB during the early 1980s with records reviews, interviews and field investigations to identify potentially contaminated sites. Subsequently Hanscom AFB, including Hanscom Field, was listed on the USEPA National Priorities List (NPL) in 1994. Of the 22 individual Hanscom AFB IRP sites with known or suspected contamination, 6 with on-going or pending remedial actions have been designated as CERCLA sites and fall under jurisdiction of the USEPA and are the subject of this review. These CERCLA sites were grouped into the following three operable units:

Operable Unit 1

- IRP Site 1 — Fire Training Area II
- IRP Site 2 — Paint Waste Disposal Area
- IRP Site 3 — Jet Fuel Residue/Tank Sludge Disposal Area

Operable Unit 2

- IRP Site 4 — Sanitary Landfill

Operable Unit 3

- IRP Site 6 — Landfill/Former Filter Beds
- IRP Site 21 — Unit 1 Petroleum Release Site

The location of these three Operable Units is shown in **Figure 1**.

Upon the designation of Hanscom Field/Hanscom AFB as a NPL Site in 1994 USEPA reviewed the listing of all of the IRP sites to identify those not subject to CERCLA because of the

CERCLA petroleum exclusion clause. IRP sites identified at this time as non-CERCLA sites included IRP Sites 9, 11, 12, 14, 15, 16, 17, and 18. Subsequently, following additional review of site investigation data, IRP Sites 13 and 22 were also determined to be non-CERCLA sites. Please note that non-CERCLA/petroleum sites are regulated by the Massachusetts Contingency Plan (MCP) with regulatory oversight by the Massachusetts Department of Environmental Protection (MA DEP).

There are 16 IRP Sites not covered by this Five-Year Review because they have either been closed-out with regulatory concurrence or are non-CERCLA sites being regulated by the MCP. The status of these 16 sites is as follows:

IRP Site	Name	Status	Date	Document
5	Fire Training Area I	Closed-out	9/27/1991	AF DD (note 1)
7	Industrial Wastewater Treatment System	Closed-out	1/22/1991	AF DD (note 2)
8	Scott Circle landfill	Closed-out	12/23/1991	AF DD (note 3)
9	Administration Building Jet Fuel Spill	Closed-out	1/22/1991	AF DD
10	Mercury Spill at Building 1128	Closed-out	12/19/1989	AF DD (note 2)
11	Various Fuel Spills on Runways & Taxiways	Closed-out	1/22/1991	AF DD
12	AAFES Service Station Gasoline Leak	Closed-out	1/22/1991	AF DD
13	Motor Pool Gasoline Leak	MCP LTM	1/19/1999	Class C RAO
14	Multi-site UST Investigation	Closed-out	10/19/2000	AF DD
15	Multi-site UST Removal	Closed-out	10/19/2000	AF DD
16	Contamination at Building T-860	Closed-out	9/30/1994	AF DD
17	Contamination at Building 1103	Closed-out	9/30/1993	AF DD
18	Contamination at Building 1102-C	Closed-out	9/30/1993	AF DD
19	Suspected Dump Site	Closed-out	9/30/1994	AF DD (note 2)
20	Suspected Fire Training Area	Closed-out	2/6/2001	OU-1 IROD
22	AAFES Service Station Petroleum Leaks	MCP LTM	8/26/1997	Class C RAO

Note 1 - Closed-out reconfirmed by OU-1 IROD dated November 2002
Note 2 - Closed-out reconfirmed by USEPA letter dated July 5, 2000
Note 3 - Closed-out reconfirmed by USEPA letter dated September 28, 2001

Land and Resource Use

Hanscom AFB is an active base owned and operated by the Federal government through the Department of the USAF. Hanscom AFB is home to the Electronic Systems Center (ESC), a dynamic nucleus of research and development. ESC is the USAF acquisition and development center for world-class command and control systems.

Hanscom Field, located adjacent to and north of the Base, is a full-service General Aviation airport owned by the Commonwealth of Massachusetts and operated by the Massachusetts Port

Authority (Massport) and the Federal Aviation Administration (FAA). However, prior to 1973, the USAF leased the runways and flight line (that are now Hanscom Field) from the Commonwealth and the primary mission of Hanscom AFB was the operational maintenance of fighter aircraft and research and development support.

Massport's 2005 L.G. Hanscom Field Environmental Status and Planning Report (ESPR) and the most recent (November 2003) Hanscom AFB General Plan Update (master plan) indicate that there are currently no plans to change the existing land use of Hanscom Field/Hanscom AFB in the future. These documents also state that potable water for Hanscom Field and Hanscom AFB is obtained from local municipal suppliers (Bedford, Concord and Lexington).

Groundwater beneath Hanscom Field/Hanscom AFB is not currently used as a drinking water supply, and it is not expected to be so used in the future. Nonetheless, MA DEP has classified groundwater in Hanscom Field/Hanscom AFB as Class I "high use and value" and the groundwater in the Town of Bedford has been designated as GW-1 (i.e., as a potential future drinking water supply) under state law by means of a Town of Bedford Aquifer Protection District by-law that was enacted through a process authorized by MA DEP and implemented through the state regulations. However, MA DEP has classified sections of the area as a Non-Potential Drinking Water Source (Medium Yield). The MCP defines "Non-Potential Drinking Water Source" as, "Those portions of high and medium yield aquifers which may not be considered as areas of groundwater conducive to the locations of public water supplies." The MA DEP groundwater classification map is included as **Figure 3**.

A well inventory was conducted for Hanscom AFB by M&E as part of the Remedial Investigation of IRP Site 6. The objective of the well inventory was to identify and locate all public water supply wells, private drinking water wells, and industrial, irrigation, and monitoring wells within a three-mile radius of Hanscom AFB. Subsequently, in October 2000, officials from Hanscom AFB met with the Director of the Board of Health in the Town of Bedford to review the location of any wells installed after the M&E survey. These surveys revealed that there are five private wells located within 1.4 miles of the northeastern corner of Hanscom AFB, in Bedford. The two nearest private wells are located 1.2 miles north-northeast, and 1.3 miles northeast of the northeastern corner of Hanscom AFB, respectively. The closest active public wells are the Town of Bedford Shawsheen Road Wellfield located approximately 2.3 miles northeast of the northeastern corner of Hanscom AFB.

OU-1/IRP Sites 1, 2 & 3: OU-1 is an area with groundwater contamination that includes three distinct areas of concern, known as IRP Sites 1, 2, and 3, which are all located on Hanscom Field. OU-1 includes parts of Hanscom Field and the wetland areas and a beaver ponded area to the north/northeast of the airfield known as the Jordan Conservation Area and Hartwell Town Forest which are owned by the Town of Bedford. There are deed restrictions on the Bedford property which limit use to passive and/or active recreation use. There is also a small section of OU-1 which is leased from the Commonwealth by Hanscom AFB and used as a campground and as the site of the central groundwater treatment facility for OU-1. The November 2003 Hanscom

AFB Base General Plan Update (master plan) identifies the campground area as "Outdoor Recreation" and the treatment facility area as "Industrial" in both the existing and future Land Use Plans. The General Plan Update also shows each of these airfield sites with "Environmental Constraints" (because of IRP Site status) and with "Operational Constraints" (due to location on Hanscom Field).

Potable water for the campground and treatment facility is provided by the Town of Bedford public water distribution system. The wetland area to the north/northeast of the airfield was delineated and named Wetland B during the Air Force Comprehensive Ecological Analysis by LEC in 1992-1995 (LEC, 1997). Wetland B is a mature forested swamp associated with a tributary of the Shawsheen River. Since the LEC investigations, beaver have dammed the drainage channel resulting in a significant portion of the former wetland becoming inundated. Therefore, the nomenclature of Wetland B/beaver pond has been adopted to represent this mixed habitat.

IRP Site 1, situated in the town of Bedford, is a former Air Force fire training area located on a relatively flat plateau on the southeast side of Hartwell Hill and northwest of Hanscom Field Runway 5-23. The area is slightly higher than the runways and the wetlands to the northeast. This area was reportedly used for fire training from the late 1960s through 1973. Today the area is fenced open space.

IRP Site 2, situated in the town of Bedford, is the site of drum burial pits located on Hanscom Field north of Runway 11-29 and east of Runway 5-23 which were used for disposing of waste solvents and paint from 1966 to 1972. The area is the same elevation as the runways and is slightly higher than the wetlands to the north. Prior to the remedial activities discussed below the site was devoid of most vegetation, possibly because of the sand cap placed over the site following the burial of the drums. Today the area is grassed open space cover by a groundwater recharge system within the security fence perimeter of Hanscom Field.

IRP Site 3, situated in the town of Concord, is the site of drum burial pits located on Hanscom Field in a triangular area bounded by Taxiway "Whiskey" to the north, Taxiway "Mike" to southwest and Runway 5-23 to the southeast. The area is the same elevation as the runways. Today the area is grassed open space cover by a groundwater recharge system within the security fence perimeter of Hanscom Field.

OU-2/IRP Site 4: IRP Site 4 is a municipal waste landfill which covers 10.5 acres and is located approximately 1,800 feet southeast of the approach end of Runway 5-23 on Hanscom Field. Pre-1964 topographic maps of the area indicate that the site was a wetland area associated with Elm Brook. As discussed below the remedial action constructed in 1988 placed an impervious cap over the area. The area is also bermed with drainage ditches to channel runoff from the capped area to the wetlands. Today the area is grassed open space with a softball field in the southern half. The landfill is situated predominantly in the town of Lincoln, with a small portion

protruding into the bordering town of Concord.

The November 2003 Hanscom AFB Base General Plan Update (master plan) identifies this airfield site as one with "Environmental Constraints" (because of IRP Site status) and with "Operational Constraints" (due to location on Hanscom Field).

OU-3/IRP Site 6: OU-3/IRP Site 6 is approximately 15 acres in area and is located in the northeast portion of Hanscom AFB and is situated in both the town of Bedford and the town of Lexington. The site is bounded to the north by a former railroad spur, to the northeast by a wetland area and small pond, to the east by a commercial industrial park, to the south by a service road (Hunter Street), and to the west by IRP Site 21, the former aviation storage facility. IRP Site 6 consists of three distinct areas: the former filter beds (including the former sludge beds) and two (2) hillside landfill areas (south and west). The former filter bed area is higher than the wetlands to the north. As discussed below the remedial action constructed in 2001 re-graded and placed a pervious cap over the three landfill areas of the site.

IRP Site 6 was classified in the 1998 Hanscom Air Force Base General Plan (master plan) as industrial in both the existing and future Land Use Plans. Based upon this designation there was a potential for future industrial use of the site. However, the 2003 General Plan Update includes the following as a change from the 1998 Plan: "Most of the area designated Industrial at ERP S 6 in the Building 1800 series area was changed to Open Space since Land Use Controls associated with the ongoing remedial action constrain development."

Today IRP Site 6 is a grassed area which is fenced and locked with "No Digging, No Dumping" signs posted. The site is periodically used by Air Force personnel for readiness training that does not require digging. The November 2003 General Plan Update identifies the Site 6 area as "Open Space" in both the Existing and Future Land Use Plans. The General Plan Update also shows the site with "Environmental Constraints" (because of IRP Site status and proximity to wetlands and the Shawsheen River) and with "Operational Constraints" (due to proximity to Hanscom Field). Through these measures the use of the site is well controlled and managed. There are currently no plans to change the existing use of IRP Site 6 in the future.

An area adjacent to the southeast portion of the site is used as a municipal waste transfer station for all municipal waste produced at Hanscom AFB and a sand and salt storage dome is located adjacent to the southwest corner of the site. Land use in adjacent and surrounding areas in close proximity to the site currently includes an occupied industrial park located east of the site, unoccupied wetland areas just north and northeast of the filter bed area, a former railroad spur to the north of the site, and an industrial area of the base to the west of the site.

OU-3/IRP Site 21: OU-3/IRP Site 21 is approximately 5 acres in area, situated in the town of Bedford, in the northeast portion of Hanscom AFB and adjacent to IRP Site 6. The Shawsheen River bounds the site to the north. IRP Site 21 is the area of a former aviation fueling facility that was used for storage, off-loading, and dispensing of jet fuel and aviation gasoline from at

least 1945 through 1973, and to store and distribute No. 2 fuel oil during the early 1970s. Fuel was stored in aboveground and underground storage tanks, which had associated pump houses and a network of underground piping. This area was also used for the storage of cleaning solvents and other petroleum products (oils and lubricants) associated with aircraft and vehicle maintenance.

Today the northern half of the site is a controlled/fenced parking area for privately owned recreational vehicles. At the time of the 2002 Five-Year Review part of this northern half of the site was use as a staging area for contractors working on the base and as a controlled/fenced general purpose storage area for bulky items that can be stored in the open. Since then the space allocated for parking privately owned recreational vehicles has been expanded at the expense of the other uses. The southern half of the site includes Building 1823, which is currently used as the base entomology facility; the former aboveground storage tank (AST) area which is currently used by the Base roads and grounds maintenance organization for equipment and materials storage, wood/brush chipping, and composting; and Buildings 1833 and 1834 used for the base's maintenance material receiving and storage. Also some of the open space/grass area in the southern half is being used for the storage of soil from the foundation excavation of a new gym elsewhere on the base. It is planned to either reuse this soil on base or at an appropriate off-base location.

The area of IRP Site 21 is classified in the Hanscom Air Force Base General Plan (master plan) as either "Outdoor Recreational" or "Industrial" in both the Current Land and Future Land Use Plans. The General Plan Update also shows the site with "Environmental Constraints" (because of IRP Site status and proximity to Shawsheen River) and with "Operational Constraints" (due to proximity to Hanscom Field). There are currently no plans to change the existing use of IRP Site 21 in the future.

History of Contamination

Hanscom AFB's initial action in implementing CERCLA was the submission of Notification of Hazardous Waste Site forms to USEPA on 5 June 1981, which identified IRP Sites 4 and 6 as landfilled areas where hazardous waste may have been disposed. Following discussions with long-time employees, this initial notification was amended with the submission of additional Notification of Hazardous Waste Site forms to USEPA on 25 June 1982, which identified IRP Sites 2 and 3 as areas sites where hazardous waste may have been disposed. Also, in 1982 IRP actions at Hanscom Field/Hanscom AFB commenced with the conduct of a preliminary investigation of IRP Site 3. Subsequently Roy F. Weston, Inc. was retained by Hanscom AFB to conduct a hydrogeologic investigation at Hanscom Field to assess the potential for past waste disposal activities at Hanscom field to impact the water quality at the Town of Bedford's Hartwell Road wellfield. This investigation confirmed the existence of contamination at IRP Sites 2 and 3 and also identified contamination in the area designated as IRP Site 1.

In 1984, JRB Associates, Inc. was retained by Hanscom AFB to complete an Installation

Assessment/Records Search. The purpose of this investigation was to identify the potential for environmental contamination from past waste management practices, evaluate the probability of contaminant migration, and assess the potential hazard posed by past disposal activities. 5 of the 6 specific sites covered by this Five-Year Review (IRP Sites 1, 2, 3, 4, & 6) were documented in this report.

In June 1990, petroleum product identified as jet fuel (JP-4) was found in a foundation investigation boring for an addition to Building 1823 and in September 1990, during the cleaning of the abandon fuel transfer pipeline, No. 2 fuel oil was released from the end of the former rail tank car unloading header. Also, in December 1990 during the removal of abandoned underground tanks connected to the floor drains of out of commission pump houses (Buildings 1818 and 1828), LNAPL was found in both of the UST excavations. Subsequently, the former fuels area was designated IRP Site 21.

OU-/IRP Sites 1, 2 & 3: OU-1 is an area with groundwater contamination that includes three distinct areas of concern, known as IRP Sites 1, 2, and 3, which are all located on Hanscom Field. These three sites are confirmed groundwater contamination source areas. Contaminants of Concern (CoCs) at OU-1 consist of chlorinated and aromatic volatile organic compounds (VOCs) and the VOCs with the highest concentrations being trichloroethene (TCE), 1,2-dichlorothene (1,2-DCE) and vinyl chloride. Dense non-aqueous phase liquid (DNAPL) is known to be present at Site 1 and is suspected to be present in other areas within OU-1. While the extent of the DNAPL is not fully known it is believe to be fully contained and within the capture zone of the existing collection system. This conclusion is supported by long-term monitoring data which has found dissolved-phase contaminant concentrations in groundwater which are indicative of nearby DNAPL only in monitoring wells up-gradient of the existing collection system.

IRP Site 1, located at the north end of the airfield was reportedly used from the late 1960s through 1973 for fire training exercises. Two (2) burn pits were used at this site. Waste oils, solvents, paint thinners, and degreasers were collected from around the base, dumped into pits, ignited, and then extinguished. Occasionally, aircraft wrecks and fuselages were burned in the pits. The size of the pits was estimated to be 15 feet by 20 feet (**Figure 4**). There is no information indicating that a liner or containment was used at these pits.

IRP Site 2, located in the northeast portion of the airfield, was used for disposing of waste solvents and paint from 1966 to 1972. Metal plating wastes may also have been disposed in this area from the early 1960s through 1972. During the 1988 removal action four (4) drum burial pits of various sizes were found and excavated (**Figure 5**). There is no information indicating whether any type of liner or containment was used at these pits.

IRP Site 3, located in a triangular area in the western portion of the airfield bounded by Taxiway "Whiskey" to the north, Taxiway "Mike" to the southwest and Runway 5-23 to the southeast. According to the Phase I Records Search several hundred drums of waste oils and paint wastes were buried at the Jet Fuel Residue Area during the period of 1959 to 1969. Disposal at the Tank Sludge Area, which is located within the same triangular area and to the northwest of the Jet Fuel Residue Area, reportedly occurred during the early 1960's. Because of the close proximity of this site to the Jet Fuel Residue Area, both areas were discussed and evaluated as one site (**Figure 6**). During the 1988 removal action ten (10) drum burial pits of various sizes were found and excavated. There is no information indicating whether any type of liner or containment was used at these pits.

OU-2/IRP Site 4: IRP Site 4, located on the southwestern corner of Hanscom Field, was used as the Hanscom AFB municipal waste landfill from December 1964 until December 1974 (**Figure 7**). During its active life, the landfill was intended to be used primarily for the disposal of solid waste. However, the IRP Phase I – Records Search report states that interviews with Base personnel confirmed that dumpsters containing waste from all shops and research laboratories were emptied into the landfill during its 10-year operation. No attempt was made to segregate hazardous materials from non-hazardous materials. A review of the 1980 chemical inventory and waste management practices of Hanscom AFB shops and resident research facilities revealed that the following types of compounds and associated empty containers were routinely discarded into dumpsters and disposed of in the landfill: battery acid; bonding compounds; fuels; medical wastes; inks and paints; mercury; photographic chemicals (developers, fixers, toners); spent acids (HF, H2SO4, HCl, HNO3); and trichloroethene (TCE) and other cleaning solvents. The landfill ranges from 10 to 15 feet deep and is estimated to have a volume of 210,000 cubic yards.

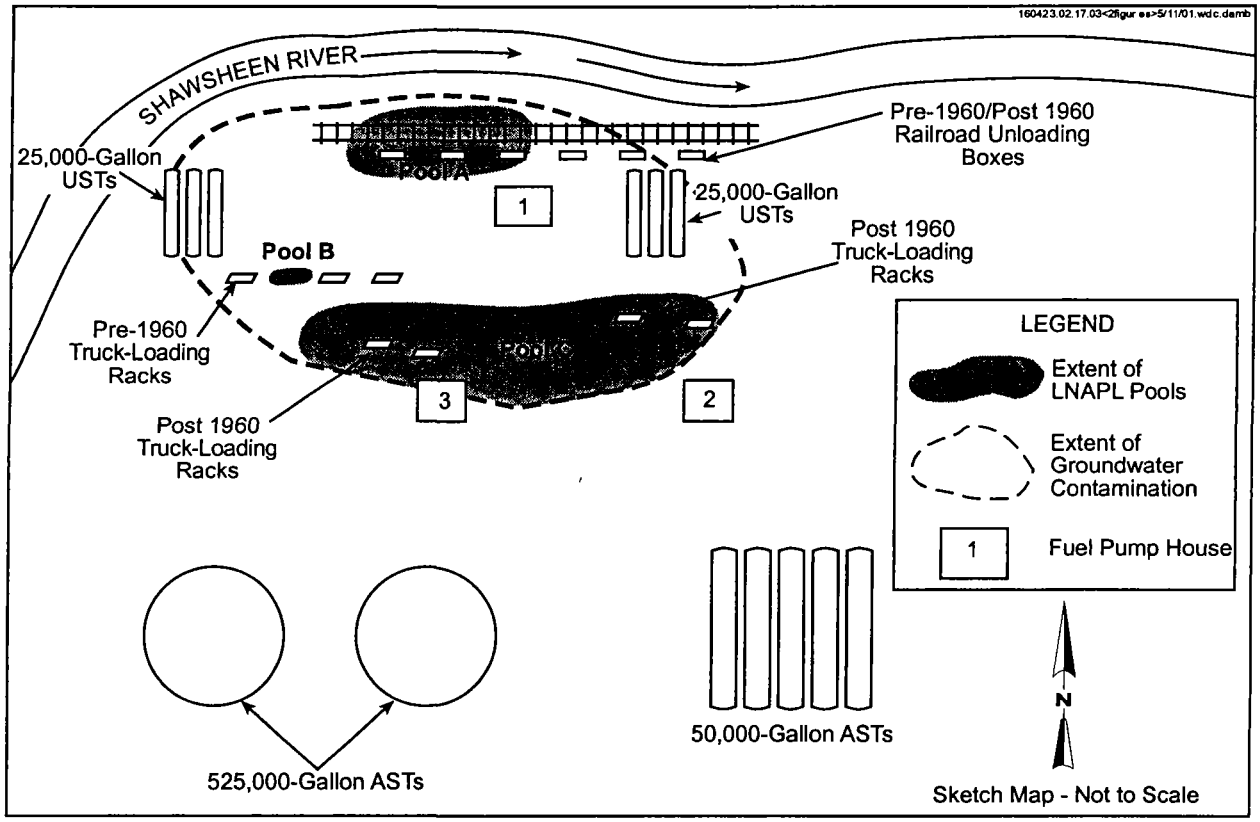
OU-3/IRP Site 6: IRP Site 6, located on the northeastern corner of Hanscom AFB, consists of three distinct areas: the former filter beds (including the former sludge beds); the south landfill (including a suspected ash disposal area and Building 1855 UST site); and the west landfill (**Figure 8**). The former filter bed area was the location of the original sanitary waste treatment system (used from 1947 until the mid 1950's) for Hanscom AFB. This system, which was abandoned in place when the Base connected to a municipal sanitary waste system, consisted of an Immoff Tank, Dosing Tank, Filter Beds (six (6) sand filled cells with a concrete berm surrounding each cell) and two (2) sludge beds. Following the abandonment of the treatment system, this area became a disposal site for municipal wastes, construction debris, and clean fill. The filter beds were overlain by approximately 5 to 15 feet of solid waste material. The Installation Restoration Program Phase I – Records Search reports an unauthorized release of 110 gallons of "Bar Kleen" and 80 gallons of "Inhibitor N-101 in the filter bed area in April 1983. These substances are boiler water treatment chemicals. Also reported were two (2) truckloads of No. 2 fuel oil soaked soil being dried on polyethylene sheets and 10-15 empty drums labeled as foaming grease. One drum was on its side and leaking rust colored liquid. Other documented releases included the burying of approximately 200 canisters of DDT in the late 1940's with about three-fourths of these canisters excavated in the early 1970s and transferred off-site. The

remaining one-fourth of these canisters was deteriorated and could not be removed. Power line insulators, sod piles, and construction debris were reportedly stored on an abandoned concrete pad. A sign in the southeast corner of the filter bed area indicated that "leaded tank sludge buried here, do not excavate."

Immediately adjacent to, and to the south of the filter bed area are two (2) hillside landfill areas (south and west). Disposal in these two areas was mainly clean fill and/or construction debris. The south landfill was originally graded into terraces at 160 to 180-foot MSL elevations, however, these were obliterated by dumping of clean fill from a building foundation excavation and construction debris in the late 80's/early 90's. The southernmost portion of the south landfill includes a suspected incinerator ash disposal area and the former UST location that was located on the west side of Building 1855. Building 1855 formerly housed an incinerator and is currently a licensed solid waste transfer station for Hanscom AFB. The UST was a 1,000-gallon steel tank used to store No. 2 fuel oil for Building 1855. This tank was installed in 1958 and removed in 1990. When the tank was removed evidence of a petroleum release was found.

OU-3/IRP Site 21: IRP Site 21 is an area with groundwater contamination and, prior to the RA, had three separate areas with petroleum products floating on the water table. These areas are technically referred to as light non-aqueous phase liquid (LNAPL) pools. Several investigations were conducted to determine what contamination exists, exactly where the contamination is located, and whether or how the contamination is moving. Concentrations of chlorinated VOCs, benzene, toluene, ethylbenzene, and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAHs), and total petroleum hydrocarbons (TPH) have been detected in various media at the site. Fortunately, data gathered during the RI and long-term monitoring program supports the conclusion that the LNAPL pools and the groundwater contamination have not migrated and have not adversely impacted the Shawsheen River which is adjacent to the northern edge of the site. The stable nature of the pre-RA product and dissolved-phase contamination is the result of the fine grained soils at the site which have high adsorptive qualities, and the natural biodegradation of the contaminants. In addition, the vertical migration of the dissolved-phase contamination is confined by a layer of glacial till that underlies the sand and gravel water table aquifer.

Today's (post-RA) layout of the area is shown on **Figure 9** and the sketch on the following page shows the historical layout of the area. Prior to 1960 the fuel distribution and storage system at IRP Site 21 consisted of a railroad tank car siding where the fuel was unloaded, six 25,000-gallon underground storage tanks (USTs), and truck loading/unloading stations located on the northern portion of the site. Post-1960 the USTs and the truck loading/unloading stations were replaced by two 525,000-gallon jet fuel and five 50,000-gallon aviation gasoline above-ground storage tanks (ASTs) and new truck loading/unloading stations located on the south side of the site. This post-1960 system also included three pump houses (#1, #2 & #3 in diagram below).



Initial Response

All of the following actions were conducted under the Air Force initiated CERCLA based IRP with the Massachusetts Department of Environmental Protection as the lead regulatory agency.

Remedial Action Plans for Hanscom Field Area 1 (IRP Sites 1, 2, 3/5 and 4): In 1985 Haley & Aldrich, Inc. (H&A) was retained to conduct investigations and prepare Remedial Action Plans for Area 1 on Hanscom Field which included IRP Sites 1 through 5 (**Figure 10**). Field investigation of the sites was conducted by H&A in 1985 and 1986. The results of this field work are included in Appendix F of the report entitled *Installation Restoration Program, Phase IV-A, Hanscom AFB Area I.* Based on the results of the field investigation H&A prepared a Remedial Action Plan for each site. Following public review of these plans, Hanscom AFB documented selection of each site's Remedial Action Plan in a *Decision Paper, Area 1 (Sites 1-5)* dated April 6, 1988. This Decision Paper was approved by the Base Commander on April 20, 1988. Please note that the Remedial Action Plan entitled IRP Sites 3/5 noted that "... field investigations have failed to indicate that fire training activities or any contamination associated with those activities can be attributed to Site 5." Thus this Remedial Action Plan did not address Site 5 and a *Decision Document for Close-Out* for Site 5, was signed by the Base Commander on 27 September 1991. This Decision Document included the determination "... that there is no basis for the existence of this site." and the declaration that "... the selected remedy is no action

and the site is hereby closed-out." Regulatory confirmation of the close out of IRP Site 5 was also subsequently documented in the OU-1 Interim Record of Decision (IROD).

Remedial Action Plans for IRP Sites 1, 2 and 3: The remedy for these sites included the removal of drums and/or visibly contaminated soil; construction of a groundwater collection, treatment and recharge system; and a long term monitoring program. Also included were four (4) Boundary Interceptor Wells along the Hanscom AFB/Massport northern property boundary with the Town of Bedford's property. The purpose of these wells is to intercept any contamination migrating off the airfield complex through the lower/glacial till and/or bedrock aquifers.

Remedial Action Plan for IRP Site 4: The remedy for this former Hanscom AFB municipal landfill included a low permeable cap, drainage measures, a compensatory wetland and long-term monitoring.

Remedial Action Design for Hanscom Field Area 1 (IRP Sites 1, 2, 3/5 and 4): H&A was also retained to design the remedial actions for IRP Sites 1, 2, 3/5 and 4. This effort commenced in December 1986 and was completed in August 1987.

Remedial Action Construction - IRP Site 1: In September 1987 Enroserv Inc. was awarded a contract for Soil Removal and Site Improvements at IRP Site 1. Field work commenced in the spring of 1988 and was completed in August 1988. There were three areas where visibly contaminated soils were excavated: Burn Pit #1, Burn Pit #1 Runoff Area, and Burn Pit #2 (**Figure 4**). A total of 2,160 tons of visibly contaminated soil was removed and transported to disposal facilities. Post-excavation survey data indicate that excavation depths averaged three to four feet in the two Burn Pits, and one to two feet in the Burn Pit #1 Runoff Area. These areas were backfilled with clean fill material.

Remedial Action Construction - IRP Sites 2 and 3: In September 1987 Hydro-dredge Corporation was awarded a contract for Drum Removal at IRP Sites 2 and 3. Field work commenced in October 1987 and was completed in June 1988. Buried drums were excavated from Sites 2 and 3 in January and February, 1988. The majority of the drums were empty and only 660 gallons of liquids were recovered. Site 2 contained 4 drum excavation pits (**Figure 5**) and Site 3 contained 10 drum excavation pits (**Figure 6**). A total of 1,896 tons of visibly contaminated soil was removed from the pits along with the drums and transported to licensed off-site disposal facilities. The pits were backfilled with the remaining excavated soil and 1,617 tons of clean fill with the intent that any residual contamination would be captured by the groundwater collection trench installed around the perimeter of the site.

Remedial Action Construction - IRP Site 4: In September 1987 WES Construction Corporation was awarded a contract for Soil Cap Old Landfill which included a low permeable cap, drainage measures, and a compensatory wetland. Field work commenced in April 1988 and

was completed in September 1988 (**Figure 7**).

Remedial Action Construction – Groundwater Collection, Treatment and Recharge System for IRP Sites 1, 2 and 3: In September 1988 R. Zoppo Co., Inc. was awarded a contract to construct a groundwater collection, treatment and recharge system for IRP Sites 1, 2 and 3. Components of the system (see **Figure 11**) included:

- Central groundwater treatment facility
- Underground piping and electrical to and from the treatment facility and remote groundwater collection points
- Upper (surface/unconfined) aquifer groundwater collection trenches with pump station at each site
- Groundwater recharge basins at IRP Sites 2 and 3
- Four boundary interceptor wells (BIWs) aligned along the Hanscom AFB/Massport northern property boundary with the Town of Bedford's property. These wells are constructed to collect groundwater from both the lower and bedrock aquifers.

The contractor received a Notice to Proceed in December 1988 and startup testing of the completed project was conducted between November 1990 and April 1991.

Long-Term Monitoring of IRP Site 4: In 1989 Environmental Resources Management, Inc. was awarded a contract to conduct long-term monitoring of groundwater and surface water at IRP Site 4. A total of seven rounds of sampling were completed between December 1989 and September 1992. Environmental Resources Management's final report for this long-term monitoring was issued in November 1992.

Technical Document to Support No Further Action Planned, IRP Site 4: This document, which was signed by the Electronic System Center Commander on 30 September 1993, states that "A permanent response action solution has been achieved (landfill cap). Groundwater and surface water monitoring has determined that a condition of no significant risk of harm to health, safety, public welfare and the environment foreseeable future exists at the site. ..... thus the selected remedy is the No further Action alternative and the site is hereby closed-out."

Remedial Action Operation – Groundwater Collection, Treatment and Recharge System for IRP Sites 1, 2 and 3: In January 1991 Metcalf & Eddy Services was awarded a contract for the operation and maintenance of the Groundwater Collection, Treatment and Recharge System for IRP Sites 1, 2 and 3. The locations of the components the Groundwater Collection, Treatment and Recharge System for IRP Sites 1, 2 and 3 are shown in **Figure 11.** Regular/daily operation of the system was started on 23 April 1991 and on 6 May 1991 the system went to around-the-clock operation (and has continued around-the clock ever since). The maximum flow capacity of the treatment facility is approximately 320 gallons per minute (gpm). **Attachment C-1** provides a summary listing of OU-1 Groundwater Collection, Treatment and Recharge

System Key Dates/Milestones. Initially groundwater was collected via the collection trenches at IRP Sites 1, 2 and 3 and from the four boundary interceptor wells (BIW-1, BIW-2, BIW-3 & BIW-4) and pumped to the central treatment facility. The collected groundwater is pumped to a 40,000-gallon equalization tank at the treatment facility and then from the equalization tank it is pumped through two air stripping towers connected in series to remove the contaminants of concern (VOCs). The water cascades downward through materials (similar to whiffle balls) within the towers while air is blown upward. Contaminants are removed from the groundwater in this process and go into a gaseous phase. The water that leaves the towers, called effluent, is sampled and analyzed to ensure that it meets regulatory discharge parameters. The treated effluent can be pumped to the recharge basins at Sites 2 and 3 (where it is returned to the groundwater) and/or discharged to a drainage channel between the treatment plant and the northeast-southwest runway of Hanscom Field. This drainage channel flows to the Wetland B/beaver pond north of Hanscom Field. The treatment facility also has an off-gas treatment system consisting of 2 granular activated carbon units connected in series which removes the VOCs from the air from the stripping towers before the air is discharged into the atmosphere.

IRP Site 1, 2 & 3 Decision Document No Further Response Action Planned: This document, which was signed by the Base Commander on 9 April 1992, states that " ..... This determination is protective of human health and the environment, and attains Federal and State requirements that are applicable or relevant and appropriate, and cost effective. This declaration is to continue operation of a pump and treat system until the groundwater meets acceptable levels."

Long-Term Monitoring of IRP Sites 1, 2 and 3: H&A was also retained to conduct the long term monitoring of IRP Sites 1, 2 and 3. Between January 1986 and October 1988 H&A completed 3 rounds of groundwater monitoring in Operable Unit 1. Round 1 (January & March 1986), Round 2 (September-October 1987) and Round 3 (September-October 1988) were associated with the development of the Remedial Action Plans, the design of the Remedial Actions and to establish a baseline prior to commencement of groundwater treatment. Round 4 (November 1990), Round 5 (February-March 1991) and Round 6 (August 1991) were designed to provide long term monitoring information on the performance of the groundwater treatment facility and the potential off-site migration of groundwater contaminants from Hanscom field. Upon review of the Round 6 data MA DEP requested that the monitoring network be expanded to better access the effectiveness of the pump & treat system. 30 additional monitoring wells were installed prior to further sampling. Subsequently Round 7 (June-July 1994) and Round 8 (November 1994) were completed.

OU-3/IRP Site 21: The initial response actions conducted at IRP Site 21 are summarized **Table 2** below.

Table 2: IRP Site 21 Remedial Actions

Date	Authority	Action	Results
1990-1991	MCP Interim Measure/DEP Case No. 3-3315	Passive Recovery System (1 recovery well) for 8 weeks in the vicinity of Building 1823. Contractor: GZA Remediation, Inc.	25 gallons of jet fuel recovered
1993	MCP Interim Measure/ DEP Case No. 3-3315	200 Linear Feet of Horizontal Recovery Trench. Operation of Soil Vapor Extraction (SVE) system for 4 months, and Groundwater Recovery/Treatment System for 8 months. Contractor: Zenone, Inc.	1,400 tons of petroleum contaminated soil removed 226,420 gallons of groundwater recovered/treated 62 gallons of petroleum product recovered 185 gallons of SVE solvent recovered
1995 thru Oct 1998	CERCLA Removal Action	9 to 13 Recovery Wells & Zenone's Recovery Trenches. Operation of Soil Vapor Extraction (SVE) and Groundwater Recovery/Treatment System Sep 95 thru Oct 98. Contractor: Kestrel Drilling and Remediation, Inc.	3,191,356 gallons of groundwater recovered/treated 1,451 gallons of petroleum product recovered 1,679 gallons of SVE solvent recovered
1999-2000	CERCLA Removal Action	3 Recovery Wells. Operation Vacuum Enhanced Recovery (VER) System Sep 99 thru Jul 00 Contractor: Arcadis Geraghty & Miller, Inc.	67,730 gallons of groundwater recovered/treated
2000-2003	CERCLA Removal Action	Continued Operation of Vacuum Enhanced Recovery (VER) System and groundwater monitoring Contractor: IT Corp	231,408 gallons of groundwater recovered/treated

Long-Term Monitoring of IRP Sites 21: A component of the Removal Action which commenced in September 1995 was the long-term monitoring of groundwater contaminant concentrations and the thickness of the LNAPL in selected IRP Site 21 monitoring and recovery wells. Long-term groundwater sampling rounds were conducted in April 1996, June 1996, December 1996, March 1997, June 1997, December 1997, April 1998, June 1998, September 1998, April 1999, July 1999, May 2000, October 2000, January 2001, May 2001, October 2001, May 2002 and October 2002.

Basis for Action

OU-1/IRP Sites 1, 2 and 3 Groundwater Contamination: CoC concentrations in OU-1 groundwater exceed federal drinking water standards (i.e., MCLs and non-zero MCLGs), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards) at many locations. As a result there is an unacceptable risk to human health from the ingestion of this groundwater. The nature and extent of groundwater contamination in the three aquifers in the OU-1 area (upper, lower, and bedrock) have been evaluated in detail through the OU-1 Long-Term Monitoring (LTM) Program. Following Hanscom's designation as a NPL site in 1994, USEPA reviewed H&A's Long-term Monitoring Rounds 7 and 8 data and requested that the monitoring network be expanded again to better access the effectiveness of the pump & treat system and to better define the nature and extent of contamination from the airfield (OU-1) sites. 22 additional monitoring wells were installed prior to further sampling.

Subsequently Round 9 (June-July 1996) and Round 10 (May 1997) were completed. During this period CH2M Hill was retained to complete CERCLA Risk Assessments, a Focus Feasibility Study and an Interim Record of Decision (IROD) for OU1. As part of this effort groundwater flow and solute transport models were developed. These indicated a need for an additional cluster (3) monitoring wells in the Bedford forest northeast of the boundary interceptor wells to confirm the models' projection of the off-site contaminated groundwater plume. The additional well cluster was installed prior to H&A's Round 11 (May 1998). The Round 11 (and subsequent monitoring) results for the additional cluster are consistent with what was projected by the model. The results of Sampling Round 11 and a summary of all earlier H&A sampling rounds are presented in the Round 11 Sampling Report (H&A, 1998). Following H&A's Round 11 the focus of the LTM Plan changed to the monitoring the effectiveness of the on-going remedial actions and progress towards attainment of RAOs and the complete cleanup of OU-1. In 1999 Hanscom AFB issued a long-term monitoring plan for OU-1 which reflected the changed focus. Also at this time the responsibility for the long-term monitoring of OU-1 (in accordance with the LTM Plan) was shifted to the contractor responsible for the operation and maintenance (O&M) of the OU-1 remedial actions. Also, since 1999, the LTM Plan has been subject to the Remedial Process Optimization (RPO) process in that sampling points and frequency are re-evaluated after each round for changes necessary to more effectively accomplish the objectives of the LTM Plan. Twenty (20) major/formal rounds of sampling and analysis in OU-1 have been performed to date, at the times listed in Table 3 on the following page.

Table 3: Schedule of Past Long-Term Monitoring Rounds													
Round No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Date (Mo/Yr)	2/86	10/87	9/88	11/90	2/91	8/91	6/94	11/94	7/96	5/97	5/98	5/99	11/99

Round No.	14	15	16	17	18	19	20						
Date (Mo/Yr	11/00	11/01	11/02	11/03	11/05	11/05	11/06						

Long-Term Monitoring Reports have been issued for each OU-1 major/formal round of sampling and analysis. Based on the historical LTM data, CoCs at OU-1 consist of chlorinated and aromatic VOCs, with the contaminants with highest concentrations being trichloroethene (TCE), 1,2-dichlorothene (1,2-DCE) and vinyl chloride. The table **at Attachment D** provides a summary of the OU-1 LTM analytical data (laboratory VOC analysis).

OU-2/IRP Site 4: As stated above, a *Technical Document to Support No Further Action Planned* for Site 4 was signed by the Commander on 30 September 1993. MA DEP subsequently requested that a risk assessment be completed in order to close-out the site. O'Brien & Gere was retained to complete a MCP Risk Assessment which included supplemental sampling and analysis at IRP Site 4. However, prior to completion of this effort, Hanscom Field/Hanscom AFB was added to the NPL and USEPA requested that CERCLA Human Health and Ecological Risk Assessments be completed instead of the MCP Risk Assessment. The site was also designated Operable Unit 2 at this time. O'Brien & Gere's scope of work was then modified to only include sampling and analysis. Field work was conducted by O'Brien & Gere between December 1994 and April 1995. The results of this field work are included in O'Brien & Gere's Report entitled *Supplemental Sampling and Environmental Update, Site 4 – Sanitary Landfill* dated February 1996.

CH2M Hill was retained to complete the CERCLA Human Health and Ecological Risk Assessments. In the process it was determined that some data gaps existed and CH2M Hill conducted additional sampling and analysis. This field work was completed in 1996 and the results provided in CH2M Hill's *Operable Unit 2 Sampling Report* dated August 1996. The CERCLA risk assessments were then completed and are found in CH2M Hill's *Baseline Human Health Risk Assessment for Operable Unit 2 (Site 4)* and *Baseline Ecological Risk Assessment for Operable Unit 2 (Site 4)*, both dated April 1997. Upon review of the Risk Assessments USEPA determined that the Remedial Action completed in 1988 was acceptable as a final remedial action. The Project Team (Remedial Project Managers for Hanscom AFB, USEPA & MA DEP) concluded that additional long-term groundwater monitoring data was not required but, since the landfill waste remains on-site, Five-Year Reviews of the remedial action were appropriate.

USEPA and Hanscom AFB completed a site inspection in May 1997 and USEPA issued the *Five-Year Review Report #1, Hanscom Air Force Base Superfund Site, Middlesex County, Massachusetts* dated September 1997. This review concluded "based on the field inspection, and human health and ecological risk assessment, protectiveness of the landfill cap at Site 4 has been demonstrated" however, the review did identify a requirement to remove scrub brush growing in the drainage ditches and on sections of the cap and berms and for a long-term inspection/ maintenance program to be instituted. The field work to remove the scrub brush was completed in the spring of 1998 and a long-term inspection and maintenance program has been instituted.

OU-3/IRP Site 6: The baseline human health risk assessment revealed that future industrial site workers potentially exposed to compounds of concern in surface soil, and future residential groundwater users may be exposed to an unacceptable human health risk that exceeds 10-4 (carcinogenic) and HI>1 (noncarcinogenic). In addition, the ecological risk assessment revealed an unacceptable risk to soil invertebrates and animals feeding 100% of the time at the landfill areas (especially the suspected Ash Disposal Area), to benthic and water column organisms in the Wetland Z area, and to the black-crowned night heron from DDT in wetland Z. The media that were sampled during field investigations include subsurface soil, surface soil, sediments (wetland and stream), surface water, and groundwater and the following **Table 4** summarizes the results of these investigations.

Table 4: OU-3/IRP Site 6 RI Results

Contaminant Type	Medium Affected	Concentration Range	Approximate Areal Extent	Suspected Source
VOCs*	Groundwater – Upper aquifer Groundwater – Lower aquifer	3.0 - 100 ug/L 0.5 – 130 ug/L	Former Filter Beds	Flushing of landfill areas
Pesticides**	Wetland sediment	0.01 – 920 ug/kg	Wetland Z sediment/north of Former Filter Beds	Landfill surface soil erosion, surface water draining from the landfill areas
SVOCs** (including PAHs)	Wetland sediment	10 - 55,000 ug/kg	Wetland Z sediment/north of Former Filter Beds	Landfill surface soil erosion, surface water draining from the landfill areas
SVOCs** (including PAHs)	Groundwater – Upper aquifer	0.27 – 180 ug/L	Former Filter Beds	Flushing of landfill areas
SVOCs** (including PAHs)	Surface soil	0.0035 – 330 mg/kg	Suspected Ash Disposal Area	Landfill debris (source area)
SVOCs** (including PAHs)	Subsurface soil	0.00084 – 12 mg/kg	South Landfill	Landfill debris (source area)
Metals*	Groundwater – Upper aquifer Groundwater – Lower aquifer	14.3 – 117,000 ug/L 22 – 14,400 ug/L	Former Filter Beds	Flushing of landfill areas
Metals*	Surface water	ND – 0.11mg/L	Ponded wetland areas	Flushing of landfill areas, surface water draining from the landfill areas

Notes:
*Human Health Risk Assessment (CH2M HILL, 1999a) exposure concentration data was used for concentration ranges.
**Ecological Risk Assessment (CH2M HILL, 1999b) exposure concentration data was used for concentration ranges.
ND – Non Detect

OU-3/IRP Site 21: CoC concentrations in OU-3/IRP Site 21 groundwater exceed federal drinking water standards (i.e., MCLs and non-zero MCLGs), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards), and the human health risk assessment revealed that future construction workers potentially exposed to LNAPL and contaminated groundwater, and future residential groundwater users may be exposed to an unacceptable human health risk that exceeds 10-4 (carcinogenic) and HI>1 (noncarcinogenic). Contaminants detected above MCLs in groundwater during the 1999 Supplemental RI are presented by sample location, i.e., beneath LNAPL Pools A, B or C or from the dissolved-phase plume; in the following **Table 5**.

Table 5: Contaminants of Concern in Groundwater – OU-3/IRP Site 21

Contaminant (exceeding MCL)	Sample Id/ Location	Maximum Concentration	MCL (Drinking Water Standard)
Source Area (LNAPL Pool A)			
Benzene	MW-10	150 ug/L	5 ug/L
Toluene	MW-10	1800 ug/L	1,000 ug/L
Naphthalene	MW-10	170 ug/L	20 ug/L[1]
Source Area (LNAPL Pool B)			
Naphthalene	ECS-33	73 ug/L	20 ug/L[1]
Source Area (LNAPL Pool C)			
Naphthalene	MWZ-20	120 ug/L	20 ug/L[1]
Groundwater Plume			
1,4-Dichlorobenzene	CH-102	390 ug/L	75 ug/L
1,2-Dichlorobenzene	CH-102	1400 ug/L	600 ug/L
1,2,4-Trichlorobenzene	ECS-31	84 ug/L	70 ug/L
vinyl chloride	ECS-28	37 ug/L	2 ug/L
cis-1,2-Dichloroethene	ECS-28	100 ug/L	70 ug/L
Trichloroethylene	MWZ-7	6 ug/L	5 ug/L
Naphthalene	MWZ-23	33 ug/L	20 ug/L[1]
Benzene	ECS-14R	73 ug/L	5 ug/L
TPH	CH-102	2,900 ug/L	200 ug/L[1]

Notes:
[1] *MCP Method 1 GW-1 standard used because no MCL exists.*

The ecological risk assessment revealed that, although a risk could not be ruled out for the Shawsheen River, the contamination detected in the river (non site-related concentrations of PAHs in the sediments and metals in the surface water) was most likely from surface water runoff from the paved areas of Hanscom Field and/or Hanscom AFB and not related to the releases regulated under CERCLA. Therefore actions to address this contamination detected in the river were not included in the remedial action, however, actions to ensure that the site's contaminants are not impacting the Shawsheen River are subject to CERCLA and are included in the remedial action. Also, it should also be noted, that the headwaters of the Shawsheen River, which includes Hanscom AFB and Hanscom Field, are the subject of intensive study through the Massachusetts Watershed Initiative established to ensure Clean Water Act compliance.

IV. Remedial Actions

Remedy Selection - OU-1/IRP Sites 1, 2 and 3

As stated above, Remedial Action Plans for IRP Sites 1, 2 and 3 were developed and implemented prior to the NPL designation. Subsequently, in 1995, USEPA advised that additional studies were necessary to ensure that these earlier actions fully addressed CERCLA requirements. Using the results of all previous investigations CH2M Hill completed a *Final Ecological Risk Assessment, OU1* (dated January 1999) and a *Focused Feasibility Study, OU1* (dated May 2000). This effort included groundwater flow and solute transport models (based on 1996 and 1997 LTM results), and an evaluation of the soil-to-groundwater contaminant transport pathway for human health risk assessment. Based on these reports and the apparent presence of DNAPL in the bedrock fractures the Project Team concluded that it was not prudent to select a final remedy at this time (2000) since compliance with ARARs would not be attained in the existing groundwater contaminant plume in the short-term. It was determined that an Interim Remedial Action should be selected/implemented. Subsequently CH2M Hill prepared an *Interim Proposed Plan for Hanscom AFB Operable Unit 1*, dated June 2000. The public review of this plan, to include a Public Information Meeting and Public Hearing on June 28, 2000, was completed in July 2000 without comment. Following the public review/comment period an Interim Record of Decision, dated November 2000, (also prepared by CH2M Hill) selecting the remedy for OU1 was signed by the Air Force on January 24, 2001 and by USEPA on February 6, 2001. The Commonwealth of Massachusetts formally concurred with this IROD by letter dated December 27, 2000.

Charts of all actual LTM results to date were presented in the 2002 Five-Year Review Report which indicated that both the contaminant mass at the Site 1 and Site 2 source areas and the contaminant concentrations in the plumes flowing from these source areas was being reduced at a rate much faster than predicted by the solute transport model. These LTM charts have been updated annually since then and the trends seen in 2002 have continued. Updated charts with LTM data through 2006 will be presented/discussed in the Data Review section of this document.

LTM results since the 2000 IROD was issued have demonstrated that the groundwater remediation system is effective at removing contaminant mass at the source areas and within the contaminant plumes. In addition, the water quality and groundwater flow data collected at the boundary wells and wells in the both the on-site plumes and the off-site plumes (Town of Bedford conservation lands) indicate that the remedial system is effective in both containing contaminant migration in each of the surface, lower and bedrock aquifers and in pulling back the plumes towards their source areas. LTM results since 1997 also appear to not support assumptions used in CH2M Hill's solute transport model that was constructed using 1996 and 1997 LTM results. That model could not predict when, if ever, RAOs would be achieved and resulted in the selection of an interim action to provided time to gather additional data.

In 2006 the Project Team concluded that the existing system is a feasible technology to achieve RAOs in a reasonable period of time and that Hanscom AFB should start the process of converting the IROD to a final ROD. Because of the apparent reduction of CVOC contaminant concentrations in site ground water that was observed in the LTM data set, in 2006 EPA Region I and Hanscom AFB partnered in preparing a "focused" solute transport model based on the LTM results and the adjusted ground water extractions rates through 2005. During a January 2007 Project Team meeting the draft model which had been prepared by EPA's consultant, CDW Consultants, Inc. was reviewed and evaluated. The focused solute transport model conservatively indicated that the existing interim remedy (dynamic groundwater remediation system) could achieve RAOs within a reasonable (30-50 years) time frame. It was concurred that the "focused" model more likely reflected actual solute transport conditions for the area modeled and those results should be incorporated into a revised focused feasibility study. The final report for the Focused Groundwater Flow and Transport Model was issued in May 2007 and a Revised Focused Feasibility Study for OU-1, prepared by Hanscom AFB, was also issued in May 2007.

Subsequently Hanscom AFB prepared a *Proposed Plan for Hanscom AFB Operable Unit 1*, dated May 2007. The public review of this plan, to include a Public Information Meeting and Public Hearing on June 20, 2007, was completed in July 2007 without comment. Following the public review/comment period a Record of Decision has prepared by Hanscom AFB and is being staffed concurrently with the preparation of this Five-Year Review Report. The remedy for OU-1 which will be selected by the ROD is basically the same as that selected by the IROD. The Commonwealth of Massachusetts is expected to formally concur with this ROD before it is signed by the Air Force and USEPA later this year. This 2007 pending ROD sets forth the final remedy for OU-1 at the Hanscom Field/Hanscom AFB NPL Site as the continued operation of the existing dynamic groundwater remediation system, land use controls including institutional controls, and the monitoring of groundwater and surface water. This remedy is expected to remove/destroy the sources of groundwater contamination, effectively contain the migration of groundwater contaminants and is expected to reduce the overall extent of the groundwater plume via a reduction in contaminant mass. The following are the major components of the selected remedy:

- Continuing to operate the existing dynamic groundwater remediation system (groundwater collection, treatment and recharge system; vacuum enhanced recovery (VER) system; molasses and/or permanganate injections).
- Continuing to maintain and enforced Land Used Controls (LUCs), including Institutional Controls (ICs), to prevent exposure to hazardous substances above permissible levels.
- Continuing an environmental sampling program (including groundwater and surface water) to monitor the performance of the groundwater remediation system and to monitor progress towards achievement of the Remedial Action Objectives (RAOs).
- Conducting Five-Year Reviews as long as any hazardous substances, pollutants or contaminants remain at the site above levels that allow for unrestricted exposure and

unlimited use to assure that the cleanup remedy continues to protect human health and the environment.

The primary objectives of the remedial measures are to:

- Prevent exposure (via ingestion, inhalation and/or dermal contact) to groundwater containing CoC concentrations that exceed federal drinking water standards (i.e., MCLs and non-zero MCLGs, state drinking water standards (i.e., MCLs), and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards);
- Prevent further migration of dissolved-phase CoCs in groundwater;
- Prevent discharge to surface-water bodies and wetlands of groundwater containing CoC concentrations that exceed federal drinking water standards, state drinking water standards, and state groundwater risk characterization standards; and
- Within an acceptable time period (<30 - 50 years), return groundwaters to federal drinking water standards, state drinking water standards, and state groundwater risk characterization standards.

Secondary objectives are to ensue that excavation at the three source areas (IRP Sites 1, 2 and 3) is controlled to prevent exposure to any residual contamination in the subsurface soil and to prevent exposure to vapors that could accumulate in buildings affected by the contaminated groundwater plume.

Remedy Selection - OU-2/IRP Site 4

A discussed above a remedy for OU-2/IRP Site 4 was selected prior to the listing of Hanscom Field/Hanscom AFB on the NPL with the MA DEP as the lead regulatory agency. The selected remedy was documented in the Remedial Action Plan for the former Hanscom AFB municipal landfill.

Remedy Selection - OU-3/IRP Site 6

Using the results of all previous investigations CH2M Hill completed a *Human Health Risk Assessment, Site 6 of OU3* and the *Ecological Risk Assessment, Site 6 of OU3* both dated July 1999. In addition to finalizing the risk assessments CH2M Hill also prepared a *Focused Feasibility Study, Operable Unit 3, Site 6 – Landfill* and *Proposed Plan for Hanscom AFB Operable Unit 3/Site 6* both dated May 2000. The public review of Proposed Plan, to include a Public Information Meeting and Public Hearing on June 20, 2000, was completed in July 2000 without comment.

A Record of Decision, dated September 2000 (also prepared by CH2M Hill) selecting the remedy for OU3/IRP Site 6 was signed by the Air Force on November 14, 2000 and by USEPA on December 5, 2000. The Commonwealth of Massachusetts formally concurred with this ROD by letter dated October 16, 2000.

Remedial action objectives (RAOs) based on the types of contaminants, environmental media of concern, and potential exposure pathways, were developed to aid in the development and screening of alternatives. These RAOs were developed to mitigate, restore and/or prevent existing and future potential threats to human health and the environment. The RAOs for the selected remedy for OU-3/ Site 6 are:

- Prevent exposure to groundwater above health-based criteria (via ingestion, inhalation, and dermal contact) within the landfill and filter bed area.
- Reduce exposure of ecological receptors to Wetland Z sediment contamination.
- Reduce potential exposure of ecological receptors to contaminated surface soils in the landfill/former filter bed area, south landfill, and west landfill.
- Prevent direct contact to surface soils within the landfill source areas (former filter bed area, south landfill, former ash disposal area, and west landfill).
- Minimize erosion of potentially contaminated soil from the former filter bed area into the adjacent pond and wetlands.

The RAOs are meant to reduce the potential exposure of future industrial site workers to PAHs in surface soil at the landfill areas via dermal contact, ingestion, and inhalation that may present a human health risk in excess of 10-4 (carcinogenic) and HI >1 (noncarcinogenic) such that the risk attributable to this medium is below 10-4 to 10-6 (carcinogenic) and has a HI which does not exceed one (noncarcinogenic) and complies with ARARs for the protection of human health and the environment. In addition, the RAOs are meant to reduce the potential exposure of children and adults to VOCs and inorganics in groundwater via ingestion, dermal contact, and inhalation that may present a human health risk in excess of 10-4 (carcinogenic) and HI >1 (noncarcinogenic) such that the risk attributable to this medium is below 10-4 to 10-6 (carcinogenic) and has a HI which does not exceed one (noncarcinogenic) and complies with ARARs for the protection of human health and the environment.

The RAOs are also meant to reduce the potential exposure of soil invertebrates and higher trophic level omnivorous animals to PAHs and inorganics in the landfill soil that are present in concentrations that may result in adverse effects for these receptors. In addition, the RAOs are meant to reduce the potential exposure of benthic organisms and the black-crowned night heron to pesticides in the wetland sediments.

The selected remedy for OU-3/IRP Site 6 consists of:

- Containment of three landfill areas,
- Removal of contaminated sediments and landfill debris and placing of this material within the capped landfill area,
- Long-term monitoring, and
- Institutional controls.

In addition, the remedy includes establishment of a groundwater compliance boundary and a Contingency Groundwater Remedy in the event monitoring results show that the remedy is not effective in maintaining groundwater quality outside the compliance boundary. A full range of options from extending the boundary, to more sampling, to active remedial measures may be considered depending on the site conditions at the time.

An expected outcome of the selected remedy is that the landfill soils and wetland sediments will no longer present an unacceptable risk to future industrial site workers and ecological receptors via dermal contact, ingestion, and inhalation. In combination with natural flushing and natural attenuation, this alternative can be expected to achieve a reduction in the size and strength of the contaminant plume within the compliance boundary. The selected remedy will also provide environmental and ecological benefits such as restoration of the wetlands areas where contaminated sediments are removed.

Remedy Selection - OU-3/IRP Site 21

Using the results of all previous investigations CH2M Hill prepared a *Feasibility Study, Operable Unit 3/ Site 21* dated June 2001 and *Proposed Plan for Hanscom AFB Operable Unit 3/Site 21* dated July 2001. The public review of Proposed Plan, to include a Public Information Meeting and Public Hearing on August 1, 2001, was completed in August 2001 without comment. A Record of Decision, dated October 2001 (also prepared by CH2M Hill) selecting the remedy for OU3/IRP Site 21, was signed by the Air Force on August 20, 2002 and by the USEPA on August 29, 2002. The Commonwealth of Massachusetts formally concurred with this ROD by letter dated January 22, 2002.

Remedial action objectives (RAOs) based on the types of contaminants, environmental media of concern, and potential exposure pathways, were developed to aid in the development and screening of alternatives. These RAOs were developed to mitigate, restore and/or prevent existing and future potential threats to human health and the environment. The RAOs for the selected remedy for OU-3/ Site 21 are:

- Prevent exposure (via ingestion, inhalation and/or dermal contact) to groundwater containing CoC concentrations that exceed federal drinking water standards (i.e., MCLs and non-zero MCLGs), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards);
- Prevent discharge to the Shawsheen River of groundwater containing CoC concentrations that exceed federal drinking water standards, state drinking water standards and state groundwater risk characterization standards;
- Prevent or minimize further migration of the contaminant plume (dissolved-phase CoCs);
- Prevent or minimize further migration of contaminants from source materials (VOCs/LNAPL) to groundwater; and

- Within an acceptable time period (< 100 years), return groundwaters to federal drinking water standards (i.e., MCLs and non-zero MCL goals (MCLGs)), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards).

The principal components of the selected remedial action for cleaning up OU-3/IRP Site 21 include:

- Three (3) interceptor trenches with passive recovery wells, one main trench covering LNAPL Pools A and B near northern boundary of the site and two smaller trenches at hotspot areas within LNAPL Pool C;
- Network of active recovery wells in non-hotspot areas of LNAPL Pool C;
- Enhancement of biodegradation of dissolved-phased contaminants (VOCs and fuel compounds) by ORC® application in all trenches;
- Monitoring;
- Land Use Controls/Institutional Controls; and
- Groundwater Containment/Treatment and VER Contingencies.
- Five-year Reviews

The primary expected outcome of the selected remedy is that the human health risks associated with the contaminated groundwater and LNAPL will be eliminated through the implementation of the selected remedy described above. Petroleum saturated soils will be removed during the installation of the trenches. Residual LNAPL not removed during construction will be contained, captured and removed through a network of active and passive recovery wells. Short term exposure to contaminants will be controlled through the use of the land use controls (LUCs)/Institutional Controls (ICs). Groundwater monitoring will confirm the effectiveness of the remedy in containing the LNAPL pools and dissolved-phase (VOCs/fuel compounds) groundwater contaminated plume from migrating to the Shawsheen River.

Remedy Implementation - OU-1/IRP Sites 1, 2 and 3

Continued Operation Of The Existing Dynamic Groundwater Collection And Treatment System: As discussed earlier in this document the remedy for OU-1/IRP Sites 1, 2 and 3 was constructed/implemented (**Figure 11**) prior to the listing of Hanscom Field/Hanscom AFB on the NPL and appropriateness of the remedy was re-confirmed by the OU-1 IROD. The term "dynamic" is included in the remedy designation in the 2000 IROD and is also included in the remedy designation in the pending 2007 ROD to reflect the Remedial Process Optimization (RPO) of the system since it was placed in operation in April 1991. Significant RPO changes include:

- In 1996 the system was automated which allowed for the reduction in operating staff/unmanned operation and the pump stations at IRP Sites 1, 2 and 3 were upgraded

with larger pumps. Subsequently in 1997 variable speed drives were added to these pumps.

- In 1997 an experimental vacuum enhanced recovery (VER) system consisting of four recovery wells was placed in operation in the immediate vicinity of Burn Pit #1 and Burn Pit #1 Runoff Area at Site 1 (**Figure 12**) to accelerate the removal of contaminant mass from the bedrock aquifer at Site 1. Following a successful Demonstration Project, this system was incorporated in the OU-1 remedy.
- In 1997 two additional conventional interceptor wells were placed in operation, one downgradient (southeast) of Site 1(IW-6) and the other downgradient (north) of Site 2 (IW-5). Also the pump in BIW #1 was replaced with a larger pump.
- In 1999 an additional conventional interceptor well was installed at Site 1 (IW-10) in the center of Burn Pit #2 and the VER system at Site 1 was augmented by the conversion of 3 monitoring wells in the immediate area to conventional interceptor wells (IW-7, IW-8 & IW-9). The groundwater collected by these wells is pumped to the central treatment facility.
- In 2000 an Environmental Security Technology Certification Program (ESTCP) project entitled: In-situ Substrate Addition to Create Reactive Zones for Treatment of Chlorinated Aliphatic Hydrocarbons: Hanscom Air Force Base commenced in the vicinity of the RAP1-6 monitoring well cluster which is considered to be in the heart of the on-site plume emanating from Site 1 (**Figure 13**). This project involved multiple injections of a substrate (molasses) into the lower aquifer slightly upgradient of the existing RAP1-6 monitoring well cluster. A total of forty-seven injections were made between October 2000 and October 2002. Over this time 1,250 gallons of raw blackstrap molasses was injected (average of 139 lbs molasses/week).
- In 2001 the pumps in BIW #3 and BIW #4 were replaced with larger pumps to take advantage of available well yield to increase the amount of contaminant mass being recovered and to enhance the on-site containment and draw back of the off-site plume being provided by the BIWs.
- In June 2001 a permanganate injection pilot study commenced in the vicinity of existing monitoring wells RAP1-3S and RAP1-3R which is also the area being remediated by the Site 1 VER system. VER system operation and recovery from IW-7, IW-8 and IW-9 were suspended for the duration of pilot study.
- In August 2001 because the TCE and cis-1,2-DCE concentrations had declined to near drinking water standards the collection and treatment of groundwater from Site 3 was suspended.
- In October 2002 the VER system restarted following conclusion of permanganate injection pilot study. However, due to iron fouling of well, pumps and discharge line IW-7, IW-8 and IW-9 were not re-activated.
- In 2003 the pump in BIW #1 was replaced with a larger pump to take advantage of available well yield to increase the amount of contaminant mass being recovered.
- In June 2006 an existing monitoring well (IRZ-2) located in the on-site plume emanating from Site 1 and downgradient of the molasses injection well was converted to a

conventional interceptor well (IW-11).

- In August 2006 the operation of the Site 1 VER system was again suspended for the duration of a permanganate treatment of the Site 1 source area in the vicinity of existing monitoring wells RAP1-3S and RAP1-3R.
- In August 2006 fouled/nearly worn out pumps in BIW No. 2 and IW No. 5 were replaced for with larger size pumps.

Land Use Controls: Due to the nature and extent of the contaminants, the current and future land use, and since OU-1/IRP Sites 1, 2 & 3 are on an active/full-service General Aviation airport; LUCs/ICs which include non-engineered instruments such as legal and/or administrative controls, will prevent exposure to, and use of, contaminated groundwater; ensure that excavation at the three source areas (IRP Sites 1, 2 and 3) is controlled to prevent exposure to any residual contamination in the subsurface soil; and prevent exposure to vapors that could accumulate in buildings effected by the contaminated groundwater plume. ICs are considered acceptable measures to be used as part of a balanced cleanup when treatment is also being used to address principle waste threats. LUCs/ICs that are being maintained, monitored and enforced under this remedy to control access to the three source areas on Hanscom Field and to ensure that the OU-1 groundwater is not used for drinking water purposed include:

- Since the early 80's Massport has granted the Air Force access to Hanscom Field for activities associated with the Hanscom AFB IRP. This access is formalized by License Agreements with the current license scheduled for renewal in September 2007.
- Massport is kept up-to-date on the status of the Hanscom AFB IRP. Both the Airport Director and Massport's Environmental Unit are on the distribution list for IRP Reports concerning OU-1 (and other IRP Reports concerning/affecting Hanscom Field). Also Massport is a chartered member of the Hanscom AFB Restoration Advisory Board (RAB).
- To alert Massport's operational personnel, planners, and decision makers of their presence, OU-1 and the locations of IRP Sites 1, 2 and 3 are noted on Figure 9-4 of Massport's 2005 L.G. Hanscom Field Environmental Status and Planning Report (ESPR) and Chapter 9 of the document includes a discussion of the Hanscom AFB IRP.
- Massport's 2005 ESPR includes forecasts for 2010 and 2020 scenarios which indicates that Hanscom Field will continue to be a full-service General Aviation airport for the foreseeable future.
- Hanscom Field has a perimeter fence and all areas of Hanscom Field are patrolled by security forces. Access to the field is controlled and restricted to authorized personnel. In addition IRP Site 1 is separately fenced.
- Construction of the OU-1 recharge basins placed 6-8 feet of clean soil over the original ground surface of the waste burial pits at IRP Sites 2 and 3. Also all visually contaminated soil at IRP sites 1, 2 and 3 was removed by the 1988 removal actions and replaced by clean backfill. Thus access to any residual subsurface soil contamination is physically restricted.

- Massport's 2005 ESPR states "The ESPR does not replace the MEPA review of projects at the site which exceed regulatory thresholds."
- IRP Sites 1, 2 and 3 are immediately adjacent to the runways, within the restrictive airfield area, and the only potential construction would be for utility services. Further, in place remedial system piping and recharge basins at Site 2 and 3 would necessitate routing of new utility services around the area with any residual subsurface soil contamination. If construction activities are planned for the airfield area in the future, appropriate health and safety procedures will be followed, including the preparation of a site specific health and safety plan, in accordance with OSHA (29 CFR 1910.120) and all other applicable federal, state, and local requirements.
- Groundwater beneath Hanscom Field/OU-1 is not used, not expected to ever be used, as a public water supply. The Public water supply for Hanscom Field is provided by Lexington (served by MWRA) and Bedford (served by MWRA and wells). Figure 9-2 of Massport's 2005 ESPR shows all public water supply facilities within Bedford, Concord, Lexington and Lincoln. Table 9-4 shows the approximate distance of each from Hanscom Field which vary from 0.9 to 7.3 miles.
- Figure 9-2 of Massport's 2005 ESPR delineates an approved Zone II Wellhead Protection Area that overlaps Hanscom Field and includes IRP Site 3. These areas are approved under the MA DEP's Drinking Water Program to protect the recharge area around public water supply groundwater sources.

In addition to the Hanscom Field area OU-1 contaminated groundwater also flows through a section of an active Air Force Installation (Hanscom AFB's Family Campground) and into conservation lands owned by the Town of Bedford. The below listed LUCs/ICs are already in-placed/instituted for that the portion of OU-1 which the Air Force leases from the Commonwealth of Massachusetts for the Hanscom AFB Family Campground and central groundwater treatment system.

Hanscom AFB LUCs/ICs are primarily documented in the November 2003 Hanscom AFB General Plan Update (master plan). Section 2.7 Responsibilities of this document states:

> The following are general responsibilities identified throughout the General Plan Update document. These are significant responsibilities that need to be brought to the attention of the Commander and users of the Plan to provide that they are implemented.
>
> **Ground Disturbance**
> Since the 1998 General Plan, several Installation Restoration Program (IRP) (now called Environmental Restoration Program, ERP) sites have been remediated (see section 4.3.3.) Any ground disturbance on the remediated sites still must be reviewed and approved by the Hanscom AFB Environmental Office before any digging begins to provide that adequate precautions are taken to mitigate risks.

Land Use Changes at ERP Sites

No changes in the current land use of the (ERP) site can be made without the written approval of the USAF government oversight Environmental Office. Also EPA and MA DEP are to be notified for consultation 45 days in advance of proposed land use changes, which are inconsistent with the land use assumptions or land uses described in the remedy selection document.

In both the Existing and Future Land Use Plans presented in the General Plan Update the OU-1 area leased by the Air Force is identified as "Outdoor Recreation" (campground area) and as "Industrial" (the treatment facility area). The General Plan Update also shows the location of each of the 3 airfield source areas (IRP Sites 1, 2 and 3) and the 3 sites and the area leased by Hanscom AFB are identified as having "Environmental Constraints" and "Operational Constraints".

The General Plan Update includes specific environmental constraints that apply to IRP Sites with Land Use Controls and/or Institutional Controls as a component of the selected remedy. The Update also includes constraints in regards to closed IRP Sites. Specific LUCs that apply to all Hanscom AFB IRP Sites include:

- No drinking water wells are allowed on the site and untreated contaminated groundwater recovered from the site cannot be used for any purpose.
- Any digging, excavation, or groundwater use on the site must be approved by the Base Environmental Office in writing and, once approved, be conducted in accordance with a site-specific health and safety plan.

A summary of all IRP Land Use Controls/Institutional Controls included in the November 2003 Hanscom AFB General Plan Update is included as **Attachment I** of this Third Five-Year Review Report.

Hanscom AFB operating procedures as defined by Air Force Instructions (AFIs) requires that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. Also Hanscom AFB contractors performing IRP work are required by OSHA to have Site Specific Health and Safety Plans and properly trained workers.

For those portions of OU-1 located on conservation lands owned by the Town of Bedford a legal mechanism is in place (deed restrictions on these lands) which limit use to passive and/or active recreation use. This area of OU-1 includes undeveloped wetlands, beaver ponded and forest areas known as the Jordan Conservation Area and Hartwell Town Forest. Additional administrative mechanisms to ensure that the groundwater under this off-site area is not used for drinking water purposes include:

- Town of Bedford officials are kept up-to-date on the status of the Hanscom AFB IRP and levels of contaminants in the groundwater beneath the town owned land. The Board of Health is furnished a copy of all OU-1 LTM Reports and both the Board of Health and Conservation Commission are on the distribution list for the monthly Remedial Action Report. Also the Board of Health Director is a chartered member of the Hanscom AFB Restoration Advisory Board (RAB) and the Chair of the Board periodically attends RAB meetings.

Also, per the pending OU-1 ROD the Air Force, in consultation with the EPA and Mass DEP, will attempt to establish restrictions prohibiting the construction of wells and the use of groundwater in any documented or anticipated area of groundwater contamination. These restrictions shall be in place within 1 year of the ROD's signature. In the event that such restrictions are not established, EPA, Mass DEP, and the Air Force will determine what alternative measures should be taken to prohibit exposure to contaminated groundwater in off-base areas.

The On- and off-site LUCs will be maintained until the concentrations of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure. The Air Force is responsible for ensuring that the LUCs described above, as components of the selected remedy, continue to be in place, are reported on, and enforced to ensure that the LUCs and are effective and protective of human health and the environment. In this regards, the Hanscom AFB environmental office will formally monitor and document the results in normal operations, maintenance, and/or monitoring reports for the remedial action. This monitoring is accomplished by:

- Frequent inspections (almost daily) of the OU-1 area by the Hanscom AFB's remedial action-operations contractor's on-site staff in the course of their OU-1 system operation, maintenance and monitoring duties, and
- Discussions at least annually, or more often if warranted between Massport and Bedford officials by the Hanscom AFB IRP Manager to verify that untreated groundwater within OU-1 is not being used for any purpose and that there is no unauthorized digging at IRP Sites 1, 2 and 3.

The monitoring results will be included in a separate annual report or as a section of another annual environmental report, if appropriate, and provided to the EPA and the Commonwealth. The annual monitoring reports will be used in preparation of the Five Year Reviews to evaluate the effectiveness of the OU-1 remedy.

Should the Air Force plan on transferring or leasing any property affected by OU-1, whether or not as a result of base closure, the Air Force will consult with USEPA and MA DEP on the specific wording on groundwater and land use restrictions to be included in the documents evidencing the transfer or lease. If the property is transferred, or the lease allows capital

improvements, a technical evaluation of the continued effectiveness and appropriateness of the remedy will be undertaken considering long-term monitoring results to date, the proposed land use, and the fact that the Air Force may no longer actively own or operate the property.

Monitoring: An extensive network (see **Figure 14**) of interceptor, recovery and monitoring wells has been developed over time to monitor contaminant levels/trends in the surface water and groundwater in each of the 3 aquifers of concern within OU-1. This remedy includes the continuation of groundwater and surface water monitoring at OU-1 which initially commenced 1986. LTM events are conducted in accordance with the Basewide Quality Assurance Project Plan for Long Term Monitoring at NPL Operable Unit 1, NPL Operable Unit 3/IRP Site 6, NPL Operable Unit 3/IRP Site 21and MCP Sites (IRP Sites 13 & 22, and the FAFSUST Site). The post-1998 LTM for OU-1 has been 2-phased; (1) the annual sampling of selected monitoring wells and a surface water sampling point for analysis of VOCs by an off-site commercial laboratory, and (2) the monthly/ quarterly/semi-annually/annually sampling of collection points, selected monitoring and the surface water sampling point for analysis by the O&M staff using an on-site gas chromatograph (GC). Please note the analysis with the on-site GC only quantifies the two principal contaminants of concern, TCE and cis-1,2-DCE. The LTM Plan has also been subject to the RPO process in that sampling points and frequency are re-evaluated after each round for changes necessary to more effectively accomplish the objectives of the LTM Plan.

The monitoring component of the IROD/pending ROD remedy continues the two-phase approach. Phase 1 is the annual sampling of selected wells to confirm established LTM trends within the OU-1 source areas and plumes and to monitor progress towards achievement of RAOs. Analysis of these samples will be for VOCs by an off-site commercial laboratory. The Phase 1 sampling and analysis will continue to be documented in a formal LTM Report. The second phase of the LTM Plan is the sampling of collection sources and monitoring wells for screening by the operations and maintenance (O&M) staff using an on-site GC. The purpose of this sampling and analysis is for system optimization (RPO) and to identify any changes in the established LTM TCE and cis-1,2-DCE trends. Results of the LTM Plan Phase 2 sampling and analysis will continue to be documented in the Monthly OU-1 Remedial Action Report which is submitted to USEPA Region I, MA DEP and stakeholders.

Remedy Implementation - OU-2/IRP Site 4

As discussed earlier in this document the remedy for OU-2/IRP 4, was constructed/implemented prior to the listing of Hanscom Field/Hanscom AFB on the NPL and the protectiveness of the remedy documented in the 1st Five-Year Review Report.

Land Use Controls (LUCs): LUCs to ensure that future land use and/or groundwater use does not increase the risk of exposure to the waste/contaminated soils and groundwater remaining on the site were **not** specified in the 1988 Remedial Action Plan for Site 4. However, inspections are made by both the Hanscom AFB IRP Manager and by Hanscom AFB's remedial action-

operations contractor's on-site staff in the course of their IRP Site 4 maintenance duties to verify the integrity of the cap and to ensure that drinking water wells are not being installed and that there is no unauthorized digging at the site. Site 4 is also on Hanscom Field within the area formally designated as a buffer area (Runway 5 Approach Area) and most of the discussion of Hanscom Field's LUCs/ICs above in the OU-1 section also applies to Site 4. As with OU-1 access to Hanscom Field by Air Force personnel/contractors to conduct IRP activities is formalized by License Agreements with the current license scheduled for renewal in September 2007. In addition Table ES-3 (Current Hanscom Field Planning Initiatives and Projects, and Potential Planning Concepts under 2010 and 2020 scenarios) in Massport's 2005 ESPR reflects that nothing is/ will be planned for Runway 5 Approach Area.

Remedy Implementation - OU-3/IRP Site 6

Remedial Design/Remedial Construction: The Remedial Design (RD) in conformance with the ROD is dated April 2001. This RD was prepared for Hanscom AFB by CH2M Hill. Construction of the remedy was completed via an Air Force Center for Environmental Excellence (AFCEE) contract with IT Corporation. IT Corporation mobilized on-site on 29 May 2001 and field work was substantially complete on September 17, 2001. The *Remedial Action Report for Landfill Capping Project at Operable Unit 3-Site 6*; prepared by IT Corporation, April 2002, describes the construction of the RA.

The major components of IT's scope of work included:

- Conducting a property line survey to verify the location of the Base property line to the north and east of the Former Filter Bed Area,
- Excavation of the contaminated sediments from two wetland hotspot areas and the placement of this material under the Former Filter Bed Area cap,
- Excavation of the debris extending off the Base property and the placement of this material under the Former Filter Bed Area cap,
- Constructing a permeable cap at the Former Filter Bed Area, South Landfill, and West Landfill,
- Restoring the wetlands in the wetland remediation areas,
- Re-establishment of perimeter and security fencing with signs on each gate, and
- As-built surveys and drawings.

The installation of three monitoring well couplets down gradient from Site 6 on adjacent landowner's property to help define a groundwater compliance boundary was also included in the scope of the construction contract. Delays in negotiating a Right-of-Entry for the Kiln Brook Spur property precluded installation of the wells during the major construction period in 2001. The Right-of-Entry was subsequently established and the wells installed in September 2002. The *Site 6 Compliance Boundary Monitoring Well Installation Report*; prepared by IT Corporation and dated January 2003 describes the installation of the wells.

Remedial Action-Operation: The remedial action-operation phase of IRP Site 6 commenced following the construction of the Remedial Action for IRP Site 6. As discussed earlier in this document the conduct of all of Hanscom AFB's on-going remedial actions since 1999 has been the responsibility of a single contractor, and, following construction, the inspection, maintenance and monitoring of the IRP Site 6 remedial action was included in the scope of work of an AFCEE remedial action contract with IT Corporation. Commencing in 2003 the A-76 process discussed earlier transferred this responsibility to MaraTech Engineering Services, Inc.

Land Use Controls (LUCs)/Institutional Controls (ICs): LUCs/ICs instituted to ensure that future land use and/or /groundwater use does not increase the risk of exposure to the waste/contaminated soils and groundwater remaining on the site are listed below. LUCs/ICs are formally monitored and results documented by the base environmental office in the recurring Remedial Action Reports issued for this site.

- Fencing with locked gates
- Signs at each of the 2 vehicle access gates stating:
  IRP Site 6
  No Digging, No Dumping
  Per Order of the Installation Commander
  For Additional Information Contact the Environmental Office
  781-377-4495/8207/4667
- Inspections are conducted by both the Hanscom AFB IRP Manager and by Hanscom AFB's remedial action-operations contractor's on-site staff in the course of their IRP Site 6 maintenance and monitoring duties to verify the integrity of the cap and to ensure that drinking water wells are not being installed and that there is no unauthorized digging at the site or in adjacent Massport and privately property (Debris Excavation Area 1, the off-site wetlands, and the former railroad spur to Hanscom AFB) which may have groundwater with dissolved arsenic levels above the arsenic MCL.
- Much of the off-base area downgradient from Site 6 is on Hanscom Field within the Runway 29 approach area and most of the discussion of Hanscom Field's LUCs/ICs above in the OU-1 section also applies to this section of Hanscom Field which may contain groundwater with dissolved arsenic levels above the arsenic MCL. As with OU-1 and OU-2, access to Hanscom Field by Air Force personnel/ contractors to conduct IRP activities is formalized by License Agreements. Massport is also on the distribution list for LTM Reports concerning OU-3/IRP Site 6.
- Rights-of-Entry are formalized with the private property owners (Debris Excavation Area 1, the off-site wetlands, and the former railroad spur to Hanscom AFB) which may contain groundwater with dissolved arsenic levels above the arsenic MCL. Each owner is formally provided with the analytical results of groundwater and surface water samples collected at these off-base locations.
- IRP Site 6 was classified in the 1998 Hanscom Air Force Base General Plan (master plan) as "industrial" in both the existing and future Land Use Plans, however, the actual land

use was "open space". With an "industrial" designation there was a potential for future industrial use of the site. Subsequently the actual "open space" land use classification was made official by the November 2003 General Plan Update which identifies the Site 6 area as "Open Space" in both the Existing and Future Land Use Plans. The General Plan Update also shows the site with "Environmental Constraints" (because of IRP Site status and proximity to wetlands and the Shawsheen River) and with "Operational Constraints" (due to proximity to Hanscom Field). Also base operating procedures (as established by Air Force Instructions) requires that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. Through these measures the use of the site is well controlled and managed. There are currently no plans to change the existing use of IRP Site 6 in the future.

- The 2003 General Plan Update includes the specific environmental constraints that apply to IRP Sites with Land Use Controls and/or Institutional Controls as a component of the selected remedy. The Update also includes constraints in regards to closed IRP Sites. Attachment I provides a summary of the specific IRP Land Use Controls/Institutional Controls included in the November 2003 Hanscom AFB Base General Plan Update.

Monitoring of Groundwater And Surface Water: A "baseline" groundwater and surface water sampling and analysis event was included in the construction contract scope/costs. The initial post-RA monitoring of the site to identify contaminants of concern in the groundwater water and surface water and to provide a baseline to monitor changes over time in the contaminant concentration levels was accomplished by IT Corporation in December 2001. The baseline event is documented the LTM report *Baseline Groundwater Monitoring Report for Post-RA Monitoring of Operable Unit 3 Site 6 (December 2001 Samples);* prepared by IT Corporation, May 2002. Subsequent post-RA LTM events have been conducted at least annually.

Wetland Mitigation Monitoring: The Remedial Design included a Five Year Monitoring Plan for the wetland areas remediated during the construction phase of the Site 6 Remedial Action. The "baseline" vegetative monitoring event for the wetland restoration areas (East Wetland Remediation Area (EWRA) and West Wetland Remediation Area (WWRA)) was included in the construction contract scope/costs and was accomplished by IT Corporation in September 2001. The baseline vegetative monitoring was performed by a qualified wetlands scientist and included the establishment of a transect line through each wetland remediation area, the placement of a 1 m x 1 m quadrant at a reproducible location, an ocular estimation of the ratio of growth to area, photographs of the wetland remediation areas from a reproducible location, and the assessment of the remedial progress. This vegetative monitoring (which established the baseline conditions for future inspections and assessments) was documented in the *Remedial Action Report for Landfill Capping Project at Operable Unit 3-Site 6*; prepared by IT Corporation, April 2002. Post-RA wetland mitigation monitoring continued in the spring and/or fall through completion of the initial Five Year Monitoring Plan in 2006.

Groundwater Compliance Boundary: The initial sampling and analysis of groundwater at existing monitoring wells selected to help define the groundwater compliance boundary was included in the 2001 baseline monitoring event. The wells selected to help define the compliance boundary have also been included in the post-RA LTM events that have been conducted at least annually. However, as stated above, the installation of three additional monitoring well couplets down gradient from Site 6 (and on an adjacent Massport or privately owned property) to better define the groundwater compliance boundary was delayed and not completed until September 2002. The initial sampling and analysis of groundwater from these wells was included in the October 2002 LTM event for Site 6. Based on the LTM results through 2005 it was concluded that there is a pocket dissolved arsenic in the surface aquifer further downgradient of the site than anticipated and that the compliance boundary should be moved further to the north, near the Shawsheen River. Three additional surface aquifer monitoring wells, all on Massport property north of the site, were installed in 2006 to better define a revised/expanded compliance boundary. These additional wells were initially sampled in July 2006 and since then have been included in the quarterly LTM events which are being conducted to evaluate seasonal changes/impacts in the off-site dissolved arsenic plume. Additional LTM results are needed to confirm that the expanded monitoring well network is sufficient to define a groundwater compliance boundary for Site 6.

At a Project Team meeting the RPMs from USEPA and MA DEP recommended that the Air Force sample to groundwater in the former off-base Debris Excavation Area 1 east of the site to confirm that the groundwater in this area (which is side gradient to the normal groundwater flow and also on privately owned property) is not being impacted by Site 6. A three well cluster (surface aquifer/lacustrine layer/lower aquifer) was installed in 2006 and the wells were initially sampled in July 2006 and again in the annual LTM event in October 2006). Analysis of the samples was for all of Site 6's CoCs (VOCs, SVOCs, pesticides, PCBs, and dissolved metals). With the exception of one questionable estimated result for thallium (a metal) the initial sampling and analysis did not identify any CoC in the former Debris Excavation Area (DEA) No. 1. Thus future LTM Plan analysis will be limited to SVOCs and dissolved arsenic which are the principal CoCs for Site 6. EPA Method (6010B) used by the laboratory for the initial metal analysis is not the best method to quantify low levels of thallium since false positive results are sometimes reported. To determined whether or not thallium is to be added as a CoC for Site 6 the DEA No. 1 cluster is scheduled to be re-sampled in the October 2007 LTM event and analyzed for thallium using Method 7841 (which has a method detection level of 0.8 ug/L).

Contingency Groundwater Remedy: Not required at this time

Remedy Implementation - OU-3/IRP Site 21

Remedial Design/Remedial Construction: The design and construction of the selected Remedial Action for IRP Site 21 was completed via an Air Force Center for Environmental Excellence (AFCEE) contract with Shaw Environmental, Inc. (formerly IT Corporation). The remedial design for the selected remedy was included in the *Environmental Cleanup Plan, Remedial Action at Operable Unit 3- Site 21, Hanscom AFB, MA*; prepared by Shaw Environmental, Inc. and dated May 2003. Shaw mobilized on-site on June 2, 2003 and field work was substantially complete in September 2003and the LNAPL recovery/groundwater treatment system officially started on September 15, 2003. The *Final Remedial Action Report for the Remedial Action at Operable Unit 3- Site 21, Hanscom AFB, MA;* prepared by Shaw Environmental, Inc. and dated March 2004 describes the construction of the RA.

The major construction components of the RA for this Site were:

- Removal of petroleum contaminated soils from various hotspot locations – a total of 2,763 tons of contaminated soil was sent transported to Eastern Soil Management Inc. for thermal treatment and reuse;
- Construction of four trenches with passive recovery wells – one main trench covering LNAPL Pool A with three passive wells, one trench covering LNAPL Pool B with two passive wells, and two smaller trenches at hotspot areas within LNAPL Pool C, each with a passive well;
- Application of ORC® in each trench to enhance the biodegradation of dissolved-phased contaminants (VOCs and fuel compounds) - a total of 1,170 pounds was applied during construction;
- Installation of a network of ten active recovery wells in non-hotspot areas within LNAPL Pool C connected to a retrofitted LNAPL recovery and treatment system that had been used at the site for previous removal actions;
- Installation of provisions to implement groundwater containment/treatment and/or enhanced vapor recovery contingencies in the future;
- Surveying and as-built drawings;
- A six-month start-up and prove-out period for the LNAPL/groundwater recovery and treatment system.

Remedial Action-Operation: The remedial action-operation phase at IRP Site 21 commenced on September 15, 2003 following the completion of the remedial action-construction phase. A six-month start-up and prove-out period for the LNAPL/groundwater recovery and treatment system was initially conducted by Shaw Environmental, Inc. This O&M period was included in the construction contract scope/costs. The construction contract also included preparation of the *Operation and Maintenance Plan, Remedial Action at Operable Unit 3- IRP Site 21* which was prepared by Shaw Environmental, Inc. in 2003. Upon completion of the start-up and prove-out period the responsibility for the operation, maintenance, and monitoring of the Site 21 Remedial Action in accordance with the O&M Plan was transferred to MaraTech Engineering Services.

Land Use Controls (LUCs)/Institutional Controls (ICs): LUCs/ICs instituted to ensure that future land use or groundwater use does not increase the risk of exposure to the waste/ contaminated soils and groundwater remaining on the site are listed below. LUCs/ICs are formally monitored and results documented by the base environmental office in the recurring Remedial Action Reports issued for this site.

- Frequent inspections (almost daily) by the Hanscom AFB IRP Manager and Hanscom AFB's remedial action-operations contractor's on-site staff in the course of their OU-1 system operation, maintenance and monitoring duties are conducted to verify that untreated groundwater within OU-3/IRP Site 21 is not being used for any purpose and that there is no unauthorized digging at the site.
- The area of IRP Site 21 is classified in the Hanscom Air Force Base November 2003 General Plan (master plan) Update as either "Outdoor Recreational" or "Industrial" in both the Current Land and Future Land Use Plans. The General Plan Update also shows the site with "Environmental Constraints" (because of IRP Site status and proximity to Shawsheen River) and with "Operational Constraints" (due to proximity to Hanscom Field). There are currently no plans to change the existing use of IRP Site 21 in the future.
- The 2003 General Plan Update includes the specific environmental constraints that apply to IRP Sites with Land Use Controls and/or Institutional Controls as a component of the selected remedy. The Update also includes constraints in regards to closed IRP Sites. Attachment I provides a summary of the specific IRP Land Use Controls/Institutional Controls included in the November 2003 Hanscom AFB Base General Plan Update.

Monitoring of LNAPL, Groundwater and Surface Water: A "baseline" groundwater and surface water sampling and analysis event was included in the construction contract scope/costs. This event also included the measurement of LNAPL thickness in monitoring and recovery wells at Site 21 which had discernable LNAPL a pre-RA monitoring events. The initial post-RA monitoring of the site to identify contaminants of concern in the groundwater water and surface water and to provide a baseline to monitor changes over time in the contaminant concentration levels and LNAPL presence was accomplished by Shaw Environmental, Inc. in October 2003 and documented in the *October 2003 Stage 2 Post-RA Baseline Long Term Monitoring Report for Operable Unit 3 – IRP Site 21*; prepared by Shaw Environmental, Inc. and dated March 2004.

Groundwater Containment/Treatment and VER Contingencies: Not required at this time.

Remedy Implementation Summary

OU-1/IRP Sites 1, 2 & 3:

- Continued operation of the existing dynamic groundwater collection and treatment system – implemented
- Land Use Controls/Institutional controls – implemented
- Monitoring of groundwater and surface water – implemented

OU-4/IRP Site 4

- Inspection and Maintenance of cap – implemented
- Land Use Controls/Institutional controls – Not formally included in the 1988 RAP, however, they have been implemented
- Monitoring of groundwater and surface water – no longer required

OU-3/IRP Site 6

- Containment of three landfill areas - completed
- Removal of contaminated sediments and landfill debris and placing of this material within the capped landfill area - completed
- Inspection and Maintenance of capped areas – implemented
- Land Use Controls/Institutional controls - implemented
- Long-term monitoring – baseline completed 2001 and annual events conduct each subsequent fall, also quarterly dissolved arsenic analysis of groundwater from selected wells commenced July 2005
- Wetland mitigation monitoring – baseline completed 2001- subsequently the Five Year Monitoring Plan included in the Remedial Design for the wetland areas remediated was completed in the fall of 2006
- Groundwater compliance boundary – implemented, however, additional monitoring data required to confirm 2006 revision
- Contingency Groundwater Remedy – no requirement at this time

OU-3/IRP Site 21

- Construction of interceptor trenches with passive recovery wells and removal of petroleum contaminated soils - completed
- Application of ORC® in interceptor trenches – completed
- Installation of LNAPL/groundwater recovery and treatment system – completed
- Operation of LNAPL/groundwater recovery and treatment system - implemented
- Land Use Controls/Institutional controls - implemented
- Long-term monitoring - implemented
- Groundwater Containment/Treatment and VER Contingencies – no requirement at this time

Remedial Action – Operation

OU-1/IRP Sites 1, 2 and 3 Remedial Action – Operation

Metcalf & Eddy Services, Inc. (subsequently acquired by Professional Services Group (PSG)) was contracted via a Corps of Engineers (CoE) service contract to operate and maintain the OU-1/IRP Sites 1, 2 and 3 groundwater collection, treatment and recharge system after it was constructed. Operation of the system commenced in April 1991. At the end of May 1996, the original service contract ended, however, PSG was awarded a CoE construction contract to upgrade and automate the collection, treatment and recharge system. PSG continued normal operations of the system during the course of the construction contract which ended in December 1998. Commencing in January 1999, IT Corporation (which was renamed Shaw Environmental, Inc. in 2003) was contracted via an AFCEE remedial action contract to operate, maintain and monitor all of Hanscom AFB's on-going remedial actions to include the OU-1 remedial action. Subsequently, in 2003 under the OMB Circular A-76 process, all of the Hanscom AFB Base Civil Engineering Services were contracted out. At this time the prime contractor, Del-Jen Inc., subcontracted all of the Environmental Protection Services, to include the Installation Restoration Program, to MaraTech Engineering Services. MaraTech continues today to serve as the Hanscom AFB remedial action-operation contractor for all on-going remedial actions to include OU-1. Of note, Metcalf & Eddy Services, Inc.'s initial system manager and the lead operator have continued to serve in these same 2 positions as responsibility for OU-1 remedial action-operation was transferred from contractor to contractor providing significant institutional knowledge on the intricacies of the system.

System Operations and Maintenance (O&M): O&M is conducted in accordance with the O&M Manual entitled Recovered Groundwater Treatment System O&M Manual. The O&M Manual was initially prepared by Engineer-Science, Inc., a subcontractor to H&A, in 1991. In 1998 the manual was revised by IT Corp, a subcontractor to PSG Inc., following completion of the system automation and upgrade contract. Under this contract a supervisory control and data acquisition (SCADA) system was installed to control and monitor system operation. The SCADA system includes remote terminal units at the pump stations at IRP Sites 1, 2 and 3 for two-way radio communication with the central control unit at the central treatment facility. Also includes an auto-dialer to notify the operating contractor of major failures during non-duty hours/periods of unattended operation.

The primary activities associated with O&M of the OU-1 Groundwater Collection, Treatment and Recharge System include the following:

- Visual checks of doors, gates, and system components to include remote sites for signs of vandalism and/or other unauthorized activity.
- Visual and computer checks of all operational equipment to include remote collection points (pump stations and interceptor wells). Repairs as necessary for proper operation.
- Adjustment of controls and computer set points necessary for efficient system operation.

- On-site and off-site commercial analysis of treatment systems (central & Site 1 VER) water quality and air quality parameters to ensure compliance with discharge standards.
- Response to major alarms during non-duty/unattended operation period. Major alarms include steam boiler failure, security alert, process down, high equalization tank level, or fire alarm.
- Scheduled/routine maintenance of equipment.
- On-site re-generation of central system's granular activated carbon units when continuous monitoring device indicates need for such.
- Major maintenance tasks as needed for efficient system operation. Includes replacement of failed pumps, replacement of "consumed" activated carbon in Site 1 VER system and in the central system (when it can no longer be regenerated on-site), pigging of collection system piping, acid cleaning of stripping towers, and cleaning/repacking of stripping towers.
- Disposal of recovered solvent at a licensed off-site disposal facility.
- Monthly Remedial Action Report

Groundwater/Surface Water Monitoring: LTM events are conducted in accordance with the Basewide Quality Assurance Project Plan for Long Term Monitoring at NPL Operable Unit 1, NPL Operable Unit 3/IRP Site 6, NPL Operable Unit 3/IRP Site 21 and MCP Sites (IRP Sites 13 & 22, and the FAFSUST Site). LTM Reports are issued for each formal/annual event and the results for the on-site GC analysis are reported in the Remedial Action Reports submitted monthly for OU-1.

Following H&A's Round 11 (May 1998), Hanscom AFB developed a LTM Plan for OU-1 and, in 1999, the requirement for the long-term monitoring of OU-1 (in accordance with the LTM Plan) was added to the scope of the existing AFCEE contract with IT Corporation (Shaw Environmental, Inc.) for the operation and maintenance (O&M) of the OU-1 remedial action. Subsequently the A-76 process discussed above transferred the responsibility of both O&M and LTM to MaraTech Engineering Services, Inc. Of note MaraTech subcontracts with Shaw Environmental, Inc. for IRP technical support, to include preparation of LTM Reports. The primary activities associated with OU-1's LTM include the following:

- Annual sampling of selected monitoring wells and one surface water sampling point with analysis for VOCs by an off-site commercial laboratory to confirm the containment and possible reduction of the OU-1 plumes. Also includes 3 wells at the Bedford Community Gardens being monitored by Hanscom for the Town of Bedford and regulators.
- Piezometric levels to monitor changes in groundwater elevations.
- Monthly sampling of collection points and selected monitoring wells for screening by the operations and maintenance (O&M) staff using an onsite gas chromatograph (GC). The purpose of this sampling and analysis is for remedial system optimization and to identify trends in VOC levels at groundwater collection points and within the OU-1 plumes. This GC analysis only quantifies the two principal contaminants of concern, TCE and cis-1,2-

DCE.

The following is a listing of OU-1 LTM Reports that have been issued since the 2002 five-year review:

- Analytical Data Package Reports for Long Term Monitoring of Operable Unit 1 - September 2002 Samples; prepared by IT Corporation, January 2003
- Analytical Data Package Reports for Long Term Monitoring of Operable Unit 1 - November & December 2002 Samples; prepared by Shaw Environmental, Inc. (formerly IT Corporation), May 2003
- Long-Term Monitoring Report for Operable Unit 1 - November 2003 Samples; prepared by Shaw Environmental, Inc., April 2004
- Long-Term Monitoring Report for Operable Unit 1 - November 2004 Samples; prepared by Shaw Environmental, Inc., March 2005
- Long-Term Monitoring Report for Operable Unit 1 - November 2005 Samples; prepared by Shaw Environmental, Inc., March 2006
- Long-Term Monitoring Report for Operable Unit 1 - November 2006 Samples; prepared by Shaw Environmental, Inc., May 2007

Remedial Action-Operation Costs: Actual operation, maintenance and monitoring costs for OU-1/IRP Sites 1, 2, & 3 that have been incurred since the remedial action-operation phase commenced in 1991 are summarized in the following Table 6.

Table 6: Annual OU-1 Remedial Action-Operations Costs

Start Date	End Date	Basic O&M Cost	LTM Cost	One-time O&M/ Alterations	Remarks
April 1991	March 1992	$551,670		$10,414	Propane & solvent disposal
April 1992	March 1993	$485,270			
April 1993	March 1994	$509,534		$63,475	Acid wash towers; solvent disposal; booster pumps,
April 1994	March 1995	$535,010		$137,243	Pigging system; iron bacteria pilot studies
April 1995	March 1996	$561,760		$25,599	Solvent & carbon disposal; Clean Site 2 Recharge Pipes, pave around plant
April 1996	December 1996	$403,425		$689,844	Automation & upgrades; Drill IWs 5 & 6
January 1997	December 1997	$342,009		$164,036	Acid Wash towers; replace BIW-1 power & pump; VFDs for pump stations; IWs 5 & 6 power& pumps; BIW & IW flow meters
January 1998	December 1998	$281,904		$58,734	Repack Towers
January 1999	December 1999	$315,347	$15,170	$73,984	Drill IW-10; power/pumps,IWs 7,8, 9 & 10; Y2K upgrades; VER carbon
January 2000	December 2000	$299,145	$20,253	$60,507	Acid wash towers; 2-Bedford Community Garden monitoring wells; VER carbon;
January 2001	December 2001	$316,080	$16,238	$31,987	Permanganate Pilot Study; VER Carbon;
January 2002	February 2003	$380,601	$23,667	$37,833	14 Months O,M&M, VER carbon
February 2003	January 2004	$321,663	In O&M	$0	11 Months O,M&M, VER carbon
February 2004	January 2005	$367,261	In O&M	$0	VER carbon
February 2005	January 2006	$355,817	In O&M	$26,473	IW-11; VER carbon
February 2006	January 2007	$369,476	In O&M	$0	Permanganate Treatment; VER carbon
February 2007	January 2008	$385,000	In O&M	$0	VER carbon

Please note the above excludes government-furnished electricity and propane costs. These utility costs were estimated to be $106,000 for 1 Feb 2007 – 31 Jan 2008

OU-2/IRP Site 4 Remedial Action – Operation

The grass on the main cap is cut periodically by Massport and a softball league at no cost to Hanscom AFB. However, the 1st Five-Year Review identified a requirement to remove scrub brush growing in the drainage ditches and on sections of the cap and berms and recommended that a long-term inspection/maintenance program be instituted. The initial field work to remove the scrub brush was completed was completed in the spring of 1998 by PSG, Inc., via a

modification to the contract providing operation, maintenance and monitoring support for the on-going OU-1 remedial action. Subsequently, since 1999, the recurring inspection and maintenance of IRP Site 4 has been included in the scope of work of the contractor responsible for the conduct of all of Hanscom AFB's on-going remedial actions. As discussed earlier in this document the A-76 process transferred this responsibility in 2003 to MaraTech Engineering Services, Inc. The contractor's annual inspection and maintenance requirements for OU-2/IRP Site 4 include:

- Periodic (usually quarterly) inspections to verify integrity of the cap and to monitor for settlement and slope instability
- Fill and/or seed low and bare areas of landfill cap
- Fill animal burrows on landfill cap
- Cut grass and brush on the berms and on the northwest lobe of the cap outside bermed (main) area of landfill cap
- Remove debris from drainage swales

The following is a listing of OU-2/IRP Site 4 Inspection Reports that have been issued since the 2002 five-year review:

- OU-2/Site 4 Long-Term Maintenance: Compilation of Quarterly Inspection Reports; prepared by IT Corporation, for 2002
- OU-2/Site 4 Long-Term Maintenance: Compilation of Quarterly Inspection Reports; prepared by MaraTech Engineering Services, for 2003
- OU-2/Site 4 Long-Term Maintenance: Compilation of Quarterly Inspection Reports; prepared by MaraTech Engineering Services, for 2004
- OU-2/Site 4 Long-Term Maintenance: Compilation of Quarterly Inspection Reports; prepared by MaraTech Engineering Services, for 2005
- OU-2/Site 4 Long-Term Maintenance: Compilation of Quarterly Inspection Reports; prepared by MaraTech Engineering Services, for 2006
- OU-2/Site 4 Long-Term Maintenance: 2007 1st and 2nd quarter Inspection Reports; prepared by MaraTech Engineering Services

Remedial Action-Operation Costs: Actual inspection and maintenance costs for OU-2/IRP Site 4 that have been incurred since the 1st Five-Year Review are summarized in the following Table 7. Please note that, though the remedy was put in place in 1988, the recurring inspections and maintenance of the site did not commence until after the 1st Five-Year Review in 1997. The below costs do not include monitoring costs since, following completion of the Human Health and Ecological Risk Assessments and the 1st Five-Year Review, the Project Team (Hanscom AFB, USEPA & MA DEP Remedial Project Managers) concluded that additional long-term monitoring data was not required.

Table 7: Annual OU-2/IRP Site 4 Remedial Action-Operations Costs

Dates		Total Cost
From	To	
October 1997	December 1998	$5,454
January 1999	December 1999	$2,933
January 2000	December 2000	$5,696
January 2001	December 2001	$4,752
January 2002	February 2003	$5,000
February 2003	January 2004	$4,549
February 2004	January 2005	$4,615
February 2005	January 2006	$2,933
February 2006	January 2007	$5,000
February 2007	January 2008	$6,000

OU-3/IRP Site 6 Remedial Action-Operation

The remedial action-operation phase of IRP Site 6 commenced following the construction of the Remedial Action for IRP Site 6 which was substantially completed in September 2001. As discussed earlier in this document the conduct of all of Hanscom AFB's on-going remedial actions since 1999 has been the responsibility of a single contractor; and, following construction, the inspection, maintenance and monitoring of the IRP Site 6 remedial action was included in the scope of work of an AFCEE remedial action contract with IT Corporation (subsequently acquired by Shaw Environmental, Inc.). Commencing in 2003 the A-76 process discussed earlier transferred this responsibility to MaraTech Engineering Services, Inc. Of note MaraTech subcontracts with Shaw for IRP technical support, to include wetland mitigation monitoring and preparation of LTM Reports. The primary remedial action-operation requirements for OU-3/IRP Site 6 include the following:

- Periodic (quarterly) inspections of fences, gates, signs and permanent survey benchmarks for integrity.
- Periodic (quarterly) inspections of the final cover for bare spots, settling, subsidence, displacement, ponding of water, erosion and unauthorized activity such as digging/excavation and well installation.
- Periodic (quarterly) inspections of Debris Excavation #1 and #2 for bare spots.
- Mowing of grassed areas of the landfill caps at least once per year prior to the fall inspection.
- Fertilizing, seeding, and mulching as required to establish and maintain grass cover.

- Periodic inspections groundwater monitoring wells for proper functioning.
- Repairs as necessary if an inspection of the landfill cap indicates that corrective action is needed to repair or restore a component of the landfill cap.
- Semi-annual and/or Annual monitoring of wetland ecosystem development in the West and East Wetland Restoration Areas, supervised by a Wetlands Scientist, at the beginning (May) and/or end (September) of the growing season.
- Annual long-term groundwater monitoring program in accordance with the LTM Plan for IRP Site 6 in order to evaluate the overall performance of the remedial alternative and to ensure groundwater quality is met outside the compliance boundary.

Inspection and Maintenance: The following is a listing of OU-3/IRP Site 6 Inspection Reports that have been issued since the 2002 five-year review:

- OU-3/Site 6 Long-Term Maintenance: Compilation of Quarterly Inspection Reports; prepared by IT Corporation, for 2002
- OU-3/Site 6 Long-Term Maintenance: Compilation of Quarterly Inspection Reports; prepared by MaraTech Engineering Services, for 2003
- OU-3/Site 6 Long-Term Maintenance: Compilation of Quarterly Inspection Reports; prepared by MaraTech Engineering Services, for 2004
- OU-3/Site 6 Long-Term Maintenance: Compilation of Quarterly Inspection Reports; prepared by MaraTech Engineering Services, for 2005
- OU-3/Site 6 Long-Term Maintenance: Compilation of Quarterly Inspection Reports; prepared by MaraTech Engineering Services, for 2006
- OU-3/Site 6 Long-Term Maintenance: 2007 1st and 2nd Quarter Inspection Reports; prepared by MaraTech Engineering Services

Groundwater/Surface Water Monitoring: LTM events are conducted in accordance with the Basewide Quality Assurance Project Plan for Long Term Monitoring at NPL Operable Unit 1, NPL Operable Unit 3/IRP Site 6, NPL Operable Unit 3/IRP Site 21and MCP Sites (IRP Sites 13 & 22, and the FAFSUST Site). The following is a listing of OU-3/IRP Site 6 LTM Reports that have been issued to date:

- Baseline Groundwater Monitoring Report for Post-RA Monitoring of Operable Unit 3 Site 6 (December 2001 Samples); prepared by IT Corporation, May 2002
- Groundwater Monitoring Report for Post-RA Monitoring of Operable Unit 3 Site 6 (October 2002 and April 2003 Samples); prepared Shaw Environmental, Inc., July 2003
- Groundwater Monitoring Report for Post-RA Monitoring of Operable Unit 3 Site 6 (September 2003 Samples); prepared Shaw Environmental, Inc., April 2004
- Groundwater Monitoring Report for Post-RA Monitoring of Operable Unit 3 Site 6 (September 2003 Samples); prepared Shaw Environmental, Inc., April 2004
- Groundwater Monitoring Report for Post-RA Monitoring of Operable Unit 3 Site 6 (October 2004 Samples); prepared Shaw Environmental, Inc., February 2005

- Groundwater Monitoring Report for Post-RA Monitoring of Operable Unit 3 Site 6 (April, July and October 2005 Samples); prepared Shaw Environmental, Inc., March 2006
- Groundwater Monitoring Report for Post-RA Monitoring of Operable Unit 3 Site 6 (January, April, July and October 2006 Samples); prepared Shaw Environmental, Inc., May 2007

Groundwater Compliance Boundary Monitoring: This monitoring is included in the LTM discussed above and the initial sampling and analysis of groundwater at existing monitoring wells selected to help define the groundwater compliance boundary was included in the 2001 baseline monitoring event. The wells selected to help define the compliance boundary have also been included in the post-RA LTM events that have been conducted at least annually. However, as stated above, the installation of three additional monitoring well couplets down gradient from Site 6 (and on an adjacent Massport or privately owned property) to better define the groundwater compliance boundary was delayed and not completed until September 2002. The initial sampling and analysis of groundwater from these wells was included in the October 2002 LTM event for Site 6. Based on the LTM results through 2005 it was concluded that there is a pocket dissolved arsenic in the surface aquifer further downgradient of the site than anticipated and that the compliance boundary should be moved further to the north, near the Shawsheen River. Three additional surface aquifer monitoring wells, all on Massport property north of the site, were installed in 2006 to better define a revised/expanded compliance boundary. These additional wells were initially sampled in July 2006 and since then have been included in the quarterly LTM events which are being conducted to evaluate seasonal changes/impacts in the off-site dissolved arsenic plume. Additional LTM results are needed to confirm whether or not the expanded monitoring well network is sufficient to define a groundwater compliance boundary for Site 6.

At a Project Team meeting the RPMs from USEPA and MA DEP recommended that the Air Force sample to groundwater in the former off-base Debris Excavation Area 1 east of the site to confirm that the groundwater in this area (which is side gradient to the normal groundwater flow and also on privately owned property) is not being impacted by Site 6. A three well cluster (surface aquifer/lacustrine layer/lower aquifer) was installed in 2006 and the wells were initially sampled in July 2006 and again in the annual LTM event in October 2006). Analysis of the samples was for all of Site 6's CoCs (VOCs, SVOCs, pesticides, PCBs, and dissolved metals). With the exception of one questionable estimated result for thallium (a metal) the initial sampling and analysis did not identify any CoC in the former Debris Excavation Area (DEA) No. 1. Thus future LTM analysis will be limited to SVOCs and dissolved arsenic which are the principal CoCs for Site 6. EPA Method (6010B) used by the laboratory for the initial metal analysis is not the best method to quantify low levels of thallium since false positive results are sometimes reported. To determined whether or not thallium is to be added as a CoC for Site 6 the DEA No. 1 cluster will be re-sampled in the October 2007 LTM event and analyzed for thallium using Method 7841 (which has a method detection level of 0.8 parts per billion).

The installation of the additional monitoring wells installed in 2006 is documented in the *Monitoring Well Installation Report for Additional Compliance Boundary Monitoring Wells*; prepared by Shaw Environmental, Inc., July 2006. This report also included a revised site map which shows the relationship of the new wells to the proposed compliance boundary revision.

Wetland Mitigation Monitoring: As noted earlier a Five Year Monitoring Plan for the wetland areas remediated during the construction phase of the Site 6 Remedial Action was initiated in September 2001. The following is a listing of OU-3/IRP Site 6 Reports on the wetland mitigation monitoring that have been issued to date:

- OU-3/Site 6, May 2002 Wetland Mitigation Monitoring, prepared by IT Corporation, August 2002
- OU-3/Site 6, September 2002 Wetland Mitigation Monitoring, prepared by IT Corporation, January 2003
- OU-3/Site 6, May 2003 Wetland Mitigation Monitoring, prepared by Shaw Environmental, Inc., August 2003
- OU-3/Site 6, September 2003 Wetland Mitigation Monitoring, prepared by Shaw Environmental, Inc., October 2003
- OU-3/Site 6, June 2004 Wetland Mitigation Monitoring, prepared by Shaw Environmental, Inc., August 2004
- OU-3/Site 6, September 2004 Wetland Mitigation Monitoring, prepared by Shaw Environmental, Inc., December 2004
- OU-3/Site 6, 2005 Wetland Mitigation Monitoring, prepared by Shaw Environmental, Inc., February 2006

OU-3/Site 6, 2006 Wetland Mitigation Monitoring, prepared by Shaw Environmental, Inc., November 2006

Remedial Action-Operation Costs: Actual inspection, maintenance and monitoring costs for IRP Site 6 that have been incurred since the remedial action was constructed in 2001 are summarized in the following **Table 8**.

Table 8: Annual OU-3/IRP Site 6 Remedial Action-Operations Costs

Dates		Total Cost
From	To	
January 2002	February 2003	$58,890
February 2003	January 2004	$46,801
February 2004	January 2005	$62,538
February 2005	January 2006	$87,525 note 1
February 2006	January 2007	$59,946
February 2007	January 2008	$60,000

Note 1: Includes non-recurring costs for 6 additional monitoring wells to better define the groundwater compliance boundary.

Remedial Action-Operation OU-3/IRP Site 21

The remedial action-operation phase at IRP Site 21 commenced on September 15, 2003 following the completion of the remedial action-construction phase. Initially there was a six-month start-up and prove-out period for the LNAPL/groundwater recovery and treatment system was conducted by the construction contractor, Shaw Environmental, Inc. (formerly IT Corporation). This O&M period was included in the construction contract scope/costs. The construction contract also included preparation of an O&M Plan dated December 2003 which was prepared by Shaw Environmental, Inc. and a post-RA "baseline" groundwater and surface water sampling and analysis event in October 2003 conducted by Shaw. Following completion of the six-month start-up and prove-out O&M period the responsibility for the operations and maintenance of the remedial action in accordance with the O&M Plan was transferred to Hanscom AFB's remedial action-operations contractor, MaraTech Engineering Services, Inc.

System operations and maintenance (O&M): O&M is conducted in accordance with the Operation and Maintenance Plan, Remedial Action at Operable Unit 3- IRP Site 21, prepared by Shaw Environmental, Inc. in December 2003. The system operations and maintenance requirements for the OU-3/IRP Site 21 remedial action include:

- Periodic (at least weekly) visual checks of all operational equipment associated with the LNAPL/groundwater recovery and treatment system and adjustment of controls as necessary for efficient system operation.
- Visual checks of doors and system components for signs of vandalism and/or other unauthorized activity.
- Periodic (normally monthly) off-site commercial analysis of the groundwater treatment system water quality parameters to ensure compliance with discharge standards.
- Periodic (normally monthly) on-site gas chromatograph (GC) analysis of samples from

the active recovery wells with a post-RA history of TCE in the recovered groundwater. Note the on-site GC is set up to only quantify TCE and cis-1,2-DCE and is not effective when BTEX compounds are also present in the sample.

- Backwashing of the groundwater treatment system GAC units and/or the sand filter when operational pressures dictate such.
- Routine maintenance and/or repair of equipment. Includes removing sludge and biomass from the oil-water separator, transfer tank, and backwash water recovery tank.
- Major maintenance tasks as needed for efficient system operation. Includes replacement of failed pumps; replacement of "consumed" activated carbon in groundwater treatment system; replacement of sand filter media; and
- Disposal of recovered LNAPL, spent carbon and other generated wastes.
- Monthly Remedial Action Report

Groundwater/Surface Water Monitoring: LTM events are conducted in accordance with the Basewide Quality Assurance Project Plan for Long Term Monitoring at NPL Operable Unit 1, NPL Operable Unit 3/IRP Site 6, NPL Operable Unit 3/IRP Site 21 and MCP Sites (IRP Sites 13 & 22, and the FAFSUST Site). LTM Reports are issued for each LTM event and the results for any on-site GC analysis are reported in the Remedial Action Reports submitted monthly for OU-3/IRP Site 21.

Pre-RA monitoring of IRP Site 21 commenced in 1995 as a component of the Removal Action. This was initially conducted by Kestrel/ECS and, since 2001, long-term monitoring of OU-3/IRP Site 21 has been conducted by Hanscom's remedial action-operations contractor. The post-RA monitoring of the site was initiated in October 2003 with a baseline monitoring round to identify contaminants of concern in the groundwater water and surface water and to provide a baseline to monitor changes over time in the contaminant concentration levels. The following is a listing of OU-3/IRP Site 21 Long-Term Monitoring Reports that have been issued since the 2002 five-year review:

- May - July 2002 Stage 1 (Pre-RA) Long Term Monitoring Report for OU-3/IRP Site 21; prepared by IT Corporation., October 2002
- October - December 2002 Stage 1 (Pre-RA) Long Term Monitoring Report for OU-3/IRP Site 21; prepared by Shaw Environmental, Inc., May 2003
- October 2003 Stage 2 Post-RA Baseline Long Term Monitoring Report for Operable Unit 3 – IRP Site 21; prepared by Shaw Environmental, Inc., March 2004
- April 2004 Post-RA Long Term Monitoring Report for Operable Unit 3 – IRP Site 21; prepared by Shaw Environmental, Inc., September 2004
- November 2004 Post-RA Long Term Monitoring Report for Operable Unit 3 – IRP Site 21; prepared by Shaw Environmental, Inc., March 2005
- April 2005 Post-RA Long Term Monitoring Report for Operable Unit 3 – IRP Site 21; prepared by Shaw Environmental, Inc., August 2005
- October 2005 Post-RA Long Term Monitoring Report for Operable Unit 3 – IRP Site 21;

prepared by Shaw Environmental, Inc., March 2006

- April and October 2006 Post-RA Long Term Monitoring Report for Operable Unit 3 – IRP Site 21; prepared by Shaw Environmental, Inc., April 2007

LNAPL Monitoring: LNAPL monitoring is a component of LTM Plan for OU-3/IRP Site 21. The site's recovery (active and passive) and groundwater monitoring wells with a post-RA history of LNAPL are periodically (some monthly) checked for the presence of LNAPL with an oil-water interface probe. Also the site's recovery and monitoring wells are checked for LNAPL during the semi-annual measurement of groundwater elevations. The results of the LNAPL monitoring are reported in the monthly RA Report or the LTM Report issued for the LTM event.

Remedial Action-Operation Costs: Actual operation, maintenance and monitoring costs for IRP Site 21 that have been incurred since the remedial action-operation phase commenced in 2003 are summarized in the following Table 9.

Table 9: Annual OU-3/IRP Site 21 Remedial Action-Operations Costs

Dates		Total Cost
From	To	
September 2003	January 2004	$1,198 note 1
February 2004	January 2005	$40,385 note 1
February 2005	January 2006	$43,011
February 2006	January 2007	$30,000
February 2007	January 2008	$30,000

Note: 1 The costs for the six-month start-up and prove-out O&M period that ended in March 2004 and a post-RA "baseline" groundwater and surface water monitoring event in October 2003 were included in construction contract.

V. Progress Since the Last Five-Year Review

General

In 2003 the OMB Circular A-76 process resulted in the contracting out of Hanscom AFB's facility maintenance, repair and alteration work and environmental protection services. Prior to this conversion this work was accomplished by a government work force augmented by contractors to a contractor work force. Starting in 2003 all of the Hanscom AFB Base Civil Engineering Services (to include environmental) were contracted out to one prime contractor, Del-Jen Inc. Del-Jen provides the required services with their on-site work force or by subcontract. From the start Del-Jen has subcontracted all of the Environmental Protection Services, to include the Installation Restoration Program, to MaraTech Engineering Services, Inc. MaraTech continues today to serve as the Hanscom AFB remedial action-operation contractor for all on-going remedial actions.

Second (2002) Five-Year Review Issues – Only the following was noted.

Issue: OU-3/IRP Site 6 - Discolored liquid seeping from the former filter bed area into the wetland remediation areas (WWRA & EWRA). This liquid was analyzed during construction of the RA (August 2001) and found to have concentrations of some metals which exceeded surface water Ambient Water Quality Criteria (AWQC) or drinking water standards (MCLs and/or MCP Groundwater Standards. At the time of the 2002 Five-Year Review there was insufficient data to determine whether or not this condition affected the current or future protectiveness of the Site 6 remedy.

Progress: Samples collected in April 2003, September 2003 and again in October 2004 were analyzed for all of the Site 6 CoCs. Since there have been no visible seeps. The results of the limited post-RA sampling and analysis of the water seeping from the side slope reflected a water quality that met the AWQC for all constituents except for iron. This iron could be the result of historic Site 6 landfilling actions but is more likely naturally occurring since the Hanscom Field/Hanscom AFB area has a significant amount of iron (as evidence by the iron filing of wells and well pumps which are components of the RA at both OU-1 and OU-3/IRP Site 21). Liquid seeping from the former filter bed area into the wetland remediation areas (WWRA & EWRA) is no longer considered to be a concern/issue since the post-RA seeps are no longer evident.

One explanation for the seeps and their subsequent disappearance is that this lateral flow (exiting the northern side slope) occurred because the RA construction activities disrupted the rain fall infiltration and/or groundwater flow patterns. Over time the infiltration and groundwater flow patterns returned to the pre-RA conditions (no seepage from the side slope). Please note that the RA re-located and re-graded the northern side

slope of the former filter bed area. The RA also included the removal of contaminated wetland sediments and landfill debris from adjacent private property and placing of this material within the capped landfill area and the re-grading of the former filter bed area.

Second (2002) Five-Year Review Recommendations and Follow-up Actions

Recommendation: Revise the OU-1 and OU-3/IRP Site 6 Long Term Monitoring Plans and continue long-term maintenance of OU-2/IRP Site 4 cap as recommended in the 1st Five-Year Review Report.

Progress: *Amendment 1* to the *Basewide Quality Assurance Project Plan for Long Term Monitoring at Operable Unit 1, NPL Operable Unit 3 – (Sites 6 &21), IRP Sites 13 & 22, and the FAFSUST Site, Hanscom AFB, MA* dated January 26, 2003 formally revised the long-term monitoring plans for OU-1 and OU-3/IRP Site 6. An additional revision to the QAPP, primarily addressing the change in remedial action-operation contractor from Shaw Environmental, Inc. to MaraTech Engineering Services, Inc. is dated July 28, 2004

Recommendation: Incorporate OU-1 IROD, OU-3/IRP Site 6 and OU-3/IRP Site 21 ROD Land Use Controls/Institutional Controls in next formal revision of the Hanscom AFB General Plan.

Progress: As noted in the Second (2002) Five-Year Review Hanscom AFB Base's 1998 General Plan (master plan) was in the process of being formally updated. This has been accomplished and Hanscom AFB Base General Plan Update was published in November 2003. The General Plan Update includes specific environmental constraints that apply to IRP Sites with Land Use Controls and/or Institutional Controls as a component of the selected remedy. The Update also includes constraints in regards to closed IRP Sites. **Attachment I** provides a summary of the specific IRP Land Use Controls/Institutional Controls included in the November 2003 Hanscom AFB Base General Plan Update.

Recommendation: Establish Memoranda of Understanding with Massport and the Town of Bedford concerning the OU-1 Institutional Controls and continue to share groundwater and surface water monitoring results with Massport, the Town of Bedford, and the Hanscom AFB Restoration Advisory Board (RAB).

Progress: During meetings with Massport and the Town of Bedford both parties indicated that they would prefer not to establish a formal Memoranda of Understanding concerning the OU-1 Institutional Controls and negotiations were suspended. Though not officially stated the Hanscom AFB environmental personnel think that the un-willingness to enter in a formal agreement was because they thought such was not necessary. However, Hanscom AFB has continued to routinely share groundwater and surface water monitoring results with Massport, the Town of Bedford, and the Hanscom AFB Restoration Advisory Board (RAB).

Recommendation: Continue on-going efforts to find effective measures to reduce OU-1 source area contamination, especially at IRP Site 1, in order to expedite groundwater cleanup.

Progress:

- Completed an Environmental Security Technology Certification Program (ESTCP) project entitled: *In-situ Substrate Addition to Create Reactive Zones for Treatment of Chlorinated Aliphatic Hydrocarbons: Hanscom Air Force Base.* This project involved multiple injections of a substrate (molasses) into the lower aquifer slightly upgradient of the existing RAP1-6 monitoring well cluster which is considered to be in the heart of the on-site plume emanating from Site 1. A total of forty-seven injections were made between October 2000 and October 2002. Over this time 1,250 gallons of raw blackstrap molasses was injected (average of 139 lbs molasses/week). For additional details please see the Final Report and the Cost and Performance Report issued for this project which are listed in the OU-1 Remedial Action Reports section of Appendix A. Also see the data review section discussions concerning "IW-11" and the "Site 1 On-Site Plume except Hanscom AFB Campground Area".
- Completed a permanganate injection pilot study in the vicinity of existing monitoring wells RAP1-3S and RAP1-3R which is also the area being remediated by the Site 1 VER system. VER system operation and recovery from IW-7, IW-8 and IW-9 were suspended for the duration of pilot study. A total of 2,750 lbs of sodium permanganate was injected over the course of three treatment events between June 18, 2001 and October 26, 2001. These injections were followed by an in-situ treatment period which lasted until October 2002 at which time the VER system was restarted. However, due to low yielding wells and iron fouling of the wells, pumps and discharge lines, IW-7, IW-8 and IW-9 were not re-activated.
- In June 2006 an existing monitoring well (IRZ-2) located in the on-site plume emanating from Site 1 and downgradient of the molasses injection well was converted to a conventional interceptor well (IW-11).
- In August 2006 the operation of the Site 1 VER system was again suspended for the duration of a permanganate treatment of the Site 1 source area in the vicinity of existing monitoring wells RAP1-3S and RAP1-3R.
- In August 2006 fouled/nearly worn out pumps in BIW No. 2 and IW No. 5 were replaced for with larger size pumps.

Recommendation: Continue on-going efforts to gathered information to support a final OU-1 remedy that will be targeted at remediating all or part of the groundwater plume.

Progress: Since 2000 significant progress has been made towards the cleanup of OU-1 and additional information has been gathered which would support the selection of a final remedy. Therefore, in 2007, a Focused Groundwater Flow and Transport Model (May 2007), a Revised Focused Feasibility Study of OU-1 (May 2007), and a Proposed Plan (May 2007) have been prepared to support this Final Record of Decision (ROD) for OU-

1. Please note that the May 2007 model predicts that there is now a reasonably estimated 30-50 year time frame to complete the cleanup. The public comment period for the OU-1 Proposed Plan was from June 8, 2007 to July 9, 2007. In addition, a public meeting and a public hearing were conducted on June 20, 2007 in Bedford, MA to discuss the OU-1 Proposed Plan and to accept oral comments.
No written comments were received during the comment period, including the public hearing. During the public hearing on June 20, 2007 oral comments were accepted from the public. Comments received during the hearing were positive and no required no changes to the Proposed Plan. Therefore the OU-1 ROD selecting the final remedy has been prepared and is currently being staffed for regulator and Air Force concurrence.

Recommendation: Continue interim cessation of active remediation of the IRP Site 3 source until monitoring indicates that it is still required or until a determination can be made that active remediation is no longer necessary.

Progress: In August 2001 because the TCE and cis-1,2-DCE concentrations had declined to near drinking water standards the collection and treatment of groundwater from Site 3 was suspended. This suspension continues to this date and LTM data documents that there has been no significant rebound in contaminant levels since active remedial measures were suspended.

Recommendation: Install proposed OU-3/IRP Site 6 compliance boundary wells.

Progress: The Installation of three monitoring well couplets down gradient from Site 6 on adjacent landowner's property to help define a groundwater compliance boundary was also included in the scope of the construction contract. Delays in negotiating a Right-of-Entry for the Kiln Brook Spur property precluded installation of the wells during the major construction period in 2001. The Right-of-Entry was subsequently established and the wells installed in September 2002.

Additional Progress

OU-1/IRP Sites 1, 2 and 3

- Continued Remedial Action – Operation (operation, maintenance and monitoring of the existing dynamic groundwater collection and treatment system).
- Continued monitoring Site 3 for rebound of contaminant concentrations (the collection and treatment of groundwater from Site 3 was stopped in August 2001 because the TCE and cis-1,2-DCE concentrations had declined to near drinking water standards.

OU-2/IRP Site 4

- Continued Remedial Action – Operation (inspection and maintenance of landfill cap).

OU-3/IRP Site 6

- Continued Remedial Action – Operation (inspection, maintenance and monitoring of capped landfill and restored wetland areas).
- Completed installation of three compliance boundary monitoring well couplets specified in the Remedial Design.
- Completed installation of three additional surface aquifer monitoring wells to support a relocation of the compliance boundary further north than initially proposed.
- Completed installation of a monitoring well cluster (surface aquifer, lacustrine aquifer & lower/till aquifer) in the area (Debris Excavation Area No. 1 on the site plan) to the east of the former filter bed area to assess the water quality it that area.
- Completed the Five Year Monitoring Plan included in the Remedial Design for the wetland areas remediated during the construction phase of the Site 6 Remedial Action.

OU-3/IRP Site 21

- Completed Remedial Design
- Completed Remedial Action Construction
- Commenced Remedial Action – Operation (operation, maintenance and monitoring of the LNAPL/groundwater recovery and treatment system).

VI. Five-Year Review Process

Administrative Components

The Third Five-Year Review of Hanscom Field/Hanscom AFB Superfund Site kicked off on 24 January 2002 at a Project Team/Five-Year Review Scoping meeting at Hanscom AFB. Attendees included:

Matthew Audet, US EPA Region 1 RPM;
Garry Waldeck, MA DEP RPM;
Joseph O'Keefe, MaraTech Engineering Services, Inc., Restoration Program Manager
Michael Quinlan, Shaw Environmental, Inc., Project Manager, and
Thomas Best, Hanscom AFB Restoration Program Manager

The Air Forces' plan was to complete the review "in-house" relying on MaraTech Engineering Services, Inc. for logistical support and Shaw Environmental, Inc. for technical support on a per tasking basis. The Project Team agreed that Hanscom should target to have the "draft" report submitted for comment by the end of July to ensure finalization in September.

Community Involvement

The Hanscom AFB Restoration Advisory Board (RAB) has been kept up-to-date as to the status of all of Hanscom AFB's on-going remedial actions. Also Minutes of meetings are sent to all RAB members and others on the RAB mailing list who did not attend the meeting. Meetings since the 2002 Five-Year review to present IRP status updates were held on:

7 October 2003
21 March 2005
20 June 2006, and
20 June 2007

Also at the June 2006 meeting and again it the June 2007 meeting the RAB was notified of both the pending Five-Year Review and on the conversion of the 2000 IROD for OU-1 to a final ROD. At these meetings the RAB was advised that the IRP Update presented at the meeting was a preliminary presentation of the Five-Year Review and that the RAB would be kept apprised of progress towards the finalization of the report.

In regards to the Proposed Plan for OU-1 the following summarizes Community Relations activities.

- Information Repositories with copies of the Revised FFS and Proposed Plan were established at the Bedford and Concord Town Libraries during the Public Comment

Period for the 2007 Proposed Plan (June 8-July 9, 2007).

- A Public Notice announcing the June 8 through July 9, 2007 public review/comment period on the 2007 Proposed Plan for NPL OU-1 was published in local and Hanscom AFB newspapers. In addition to the dates of the review/comment period this notice included a brief analysis of the 2007 Proposed Plan, the time and date of a public informational meeting and a hearing concerning the of the 2007 Proposed Plan, and the availability of the Revised FFS and Proposed Plan in the Bedford and Hanscom Libraries (June 7, 2007)
- Proposed Plan and information on public comment period, public meeting and hearing sent to Bedford (Town Manager, Board of Health & Conservation Commission), and Concord (Town Manager & Board of Health), Massport (Hanscom Field Airport Director & Environmental Unit) and Navy (June 7, 2007)
- Public Comment Period concerning the 2007 Proposed Plan for NPL OU-1 was from June 9 to July 10, 2000. Copies of the Revised FFS and Proposed Plan were on file at the Bedford and Concord Town Libraries for the duration of the Public Review/Comment Period.
- On June 20, 2007, Hanscom AFB and USEPA held an informational meeting at the Bedford Town Hall to discuss the cleanup alternatives presented in the Revised FFS and to present the Air Force's Proposed Plan to a broader community audience than those that had already been involved at the site. At this meeting, representatives from USEPA and Hanscom AFB responded to questions from the public.
- On June 20, 2007, Hanscom AFB and USEPA held a public hearing at the Bedford Town Hall to accept any oral comments on the Proposed Plan. A transcript of this meeting is included as Attachment B to Appendix B of the pending Final ROD for OU-1.

Community Relations activities in regards to this Third Five-Year Review include:

- The Draft-Final Report was placed in the Bedford Town Library and the Hanscom AFB Library and a notice placed in the local papers announcing a August 10th through September 10th public comment period.
- Memorandums dated August 6th with a copy of the Executive Summary was sent to the RAB mailing list and to officials of the 4 surrounding communities and Massport advising of the public review of the Draft-Final Report and inviting participation.

Document Review

This five-year review consisted of a review of relevant documents including O,M&M records (see **Attachment A - List of Documents Reviewed**). In addition applicable groundwater cleanup standards, as listed in the RODs for OU-3/IRP Site 6, OU-3/IRP Site 21 and the pending ROD for OU-1, were reviewed (see **Attachment B**).

Data Review

OU-1/IRP Sites 1, 2 and 3 - Operational Data for the "dynamic" Groundwater Remediation System.

General: See **Figures 11** and **12** for the locations of the components of OU-1 Groundwater Remediation System and **Attachment C-1** for a summary listing of OU-1 Groundwater Remediation System's Key Dates/Milestones since the 1991 startup. The Second (2002) Five-Year Review presented a detailed summary of the operational records from system startup in 1991 through the end of calendar year 2001. This, the Third, Five-Year Review primarily addresses the data that has been generated since the start of 2002. Operational Data is reported in the monthly NPL OU-1 Remedial Action Report which is submitted to stakeholders. See **Attachment C-2** for the Hanscom AFB NPL OU-1 Remedial Action Report for December 2006. Note, page 2 of the report includes operational data by month for calendar year 2006. A six-year summary of key operational data is presented below. Of special note is the durability/ dependability of the system as evidenced by the time-operating percentages. Normally there are only minor/short interruptions of operation for maintenance, minor repairs or equipment swaps. Also please note that all gpm data is based on continuous around-the-clock operation without regard to inoperable periods, e.g., a pump's operating rate is 10 gpm but the pump only operates 50% of the possible minutes thus its average gpm is reported as 5.

Table 10 – OU-1 Groundwater Remediation System Operational Data

	2001	2002	2003	2004	2005	2006
Million Gallons Processed	127.3	92.1	103.8	92.1	84.4	74.6
Average gpm	242.3	175.2	197.5	174.8	160.5	142.0
VER Contribution - gpm	1.4	0.6	0.5	1.1	0.5	0.9
On-site Recharge - gpm	57.0	6.2	8.5	10.4	6.2	2.8
Time Operating	97.8%	97.3%	95.5%	99.2%	99.3%	98.6%
Influent VOCs - ug/L	351.2	496.4	318.8	304.9	243.2	249.5
Effluent VOCs - ug/L	bdl	bdl	bdl	bdl	bdl	bdl

Note VOC data is the average of all monthly samples. Bdl = below detection levels

Collection System: The OU-1 groundwater treatment system has processed between 100 to 320 gallons per minute since it became operational and, as of 31 December 2006, a total of 1.688 billion gallons of groundwater had been collected/treated. **Attachment C-3** is a chart of gallons treated annually since the 1991 startup. **Table 11** on the following page breaks out the gallons treated annually since the 1998 by the individual collection sources. 1998 has been selected as the starting year for this table because it was the year that collection/treatment gallons peaked. Please note the significant change between 2000 and 2002 is principally due to the cessation of recovery from the Site 3 Trench on August 22, 2001.

Table 11 – OU-1 Groundwater Remediation System Collection System Data

	Average gpm								
Collection Source	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Site 1 Trench	24.5	19.4	20.5	14.0	14.7	19.1	15.5	21.2	14.1
Site 1 VER System	0.9	0.8	1.4	0.6	0.1	0.5	1.1	0.5	0.9
BIW #1	26.6	21.6	18.3	17.6	15.1	15.7	14.5	14.7	14.4
BIW #2	7.5	8.2	7.4	7.9	7.8	2.7	2.3	1.1	2.0
BIW #3	18.4	20.4	18.3	46.2	48.1	48.1	49.1	41.5	22.7
BIW #4	9.2	10.3	11.3	15.9	25.4	24.4	22.2	13.5	5.6
IW-5 (Site 2)	9.1	4.0	1.0	2.8	1.6	0.3	0.2	0.5	0.9
IW-6 (Site 1)	4.0	3.5	3.7	3.6	3.4	3.3	3.3	3.2	1.8
IW-7-8-9 (Site 1)		0.6	0.1		nil				nil
IW-10 (Site 1)		0.2	0.5	0.5	0.4	1.2	0.5	0.2	0.2
IW-11 (Site 1)									0.4
Site 2 Trench	105.9	74.6	79.7	65.6	58.6	82.1	65.9	64.2	79.1
Site 3 Trench	77.3	99.5	98.1	67.4	nil	0	0	0	0
Total	283.5	263.1	260.5	242.3	175.2	197.4	174.8	160.5	142.0

Though the system is designed for 320 gpm, the actual quantity processed as shown above has varied due to operational and other factors. Shortly after the 1991 startup flow from the collection sources became restricted by the growth in the pipes from the pump stations at Sites 1, 2 and 3 to the treatment facility of naturally occurring bacteria that thrives on the iron rich groundwater. This problem was initially overcome by booster pumps and the "pigging" (mechanical cleaning) of the lines. Then, in 1996/7, a project which made major system alterations upgraded the 3 pump stations' pumps to provide the capability to overcome the pipe fouling and **pump more from the pump stations than the treatment facility can process.** This situation continues to the present.

While getting groundwater from the sources to the treatment facility is no longer a problem, collecting the groundwater (getting it out of the ground) is constrained by the design and efficiency of the collection system, and by the weather; e.g., drought conditions result in lower groundwater elevations/reduced amount of groundwater available. As noted earlier the initial (1991) collection system has been augmented by additional interceptor wells (IW-5 thru 11) and the Site 1 source area VER system. Also the original Boundary Interceptor Wells' pumps have been upgraded to capture all that the wells will yield. These changes increased the amount that been upgraded to capture all that these wells will yield. These changes increased the amount that at can be extracted from the ground. On the operational side, i.e., O&M shutdowns, pump/power failures and control problems have a short term negative impact on the amount that at can be extracted from the ground. Operational issues are eventually resolved, however, an interceptor well's yield as well as the well pump's efficiency slowly decreases over time due to normal wear

and tear, the silting up of the well, and the same iron bacteria fouling that's affecting the piping to the treatment facility. This condition is evident by the monthly pumping rates for the four (4) BIWs (see Chart/**Attachment C-4)** of the yearly average pumping rates for the BIWs since flow meters were installed in 1998. In recent years the **quantity of groundwater that can extracted by the BIWs/IWs has been declining,** but not to the extent that the effectiveness of the remedial action is threatened. Eventually, if/when considered necessary to maintain the effectiveness of the remedial action, an attempt to rehabilitate the low yielding wells will be necessary. If this rehabilitation effort is not successful then new/additional interceptor wells may have to be installed.

Collection System Discharge/Treatment System Influent: The total quantity collected for treatment is only part of the assessment of the effectiveness of the collection system. Just as important is the level of contamination being captured. Subsequent sections of this document include a presentation and discussion of levels of contamination being captured at each distinct collection source while this section addresses the levels and trends of VOCs in the treatment system's influent. The groundwater collected from each source is pumped through the collection system and discharged into an equalization tank at the treatment facility prior to being treated. This process results in the treatment system's influent being a composite sample. From 1991 through 1998 weekly samples of the system's influent were analyzed for VOCs by a commercial laboratory. Starting in 1999 the frequency of laboratory analysis was changed to monthly. See **Attachment C-5** for a chart of influent trichloroethene (TCE) concentrations from the 1991 startup through the end of 2006. This chart is formatted to show the range of TCE collected in a calendar year with a line from the last analysis of the year connected to the first analysis in the following year. Please note TCE is the predominant VOC in OU-1's groundwater and, under suitable natural conditions, it eventually biodegrades; initially into cis-1,2-dichloroethene (cis-1,2-DCE), then to vinyl chloride, and finally to ethylene. Ethylene is a harmless compound, however, the complete TCE biodegradation process can take years/decades depending on the natural conditions. In the meantime the other compounds are not harmless and are the target of the OU-1 remedial action. See **Attachment C-6** for a table of the concentrations of the different VOCs found in the influent from the 1991 startup through the most recent analysis. An analysis of the influent analytical data finds that TCE and the initial breakdown compound, cis-1,2-DCE, account for ~ 95% of the VOCs being removed.

As seen in **Attachment C-5** there were wide swings in the TCE concentrations through 1998. This is not unexpected as slugs of contamination are collected and processed. Also obvious is a decreasing trend punctuated by a significant jump up in 1997. The decreasing trend is also not unexpected as the initial pool of dissolved-phase contamination within the collection system's zone of influence is readily collected. This is replaced by "cleaner" groundwater moving into the zone which picks up additional contamination dissolving from that absorbed onto the soil and, over time, the amount absorbed onto the soil decreases resulting in lower and lower concentrations entering the collection system. The decreasing trend is evidence of progress towards cleanup but also reflects a decreasing trend in the cost effectiveness of the remedial

action.

The 1997 jump up in concentrations reflects the Remedial Process Optimization (RPO) process begun in 1996 to increase both the cleanup effectiveness and the cost effectiveness of the remedial action. At that time the following collection system priorities were established to operate the treatment facility as close to the system's treatment capacity as possible while maximizing influent contaminant concentrations:

Priority 1 - Site 1 Collection Trench, Site 1 VER System, 4 BIWs and IWs
Priority 2 - Site 2 Collection Trench
Priority 3 - Site 3 Collection Trench

Prior to 1997 Site 3, per the original design of the collection system, made up the majority of the treatment system's influent since the Site 3 collection trench physically "yields" more than the other collection points. However, by 1997, Site 3 was the least contaminated of the sources and groundwater collected from Site 3 was in essence diluting the composite influent. Also slightly evident on Chart/**Attachment C-5** is a minor jump up of TCE concentrations at the end of 2001/start of 2002 which reflects the cessation of collection from Site 3 in August 2001. While **Attachment C-5** presents the big picture much of the detail in post-97 years is lost due to the scale. See **Attachment C-7** for a chart of yearly average TCE and cis-1,2-DCE concentrations in the influent starting in 1997 through December 2006. On this chart it is evident that the concentrations are leveling off (at relatively low levels) and that, if operating conditions remain the same, future decreases will take longer to materialize and be much less cost effective. This asymptotic condition is not an uncommon condition for mature pump & treat systems.

Treatment System: Air stripping towers are very effective at removing VOCs from groundwater and the effectiveness of the OU-1 groundwater treatment system was documented and discussed extensively in the Second (2002) Five-Year Review. The OU-1 system has 2 air stripping towers in series with tower 1 always the lead tower. To ensure the continued compliance with discharge ARARs weekly samples of the treatment system's (tower 2) effluent are analyzed for VOCs by the O&M staff using the on-site GC and, once a month, a duplicate is also analyzed by a commercial laboratory to be compared to/validate the on-site GC results. From startup through the most recent sample the **effluent has met and continues to meet the** discharge ARARs/drinking water standards, almost always with no detections of any VOC. Additionally, the mid-fluent (discharge from tower 1) is monitored to assess the tower's effectiveness and to identify tower maintenance requirements. As with the effluent, weekly samples of the mid-fluent are analyzed for VOCs by the O&M staff using the on-site GC and, once a month (through April 2006), a duplicate was also analyzed by a commercial laboratory to be compared to/validate the on-site GC results. For 2002-2006 the **mid-fluent** samples VOC concentrations have **also always been below the instrument's/method detection levels.**

The fact that all of the system's influent VOCs are usually removed by tower 1 is not surprising

since the system is significantly over-designed, especially for today's contaminant levels discussed above (and even for the initial/1991 levels which had a high of 5,300 ug/L for TCE). The OU-1 groundwater treatment system was designed for the following influent concentrations:

TCE	= 45,000 ug/L
Trans-1,2-DCE	= 7,500 ug/L
1,2-DCA	= 820 ug/L
Vinyl Chloride	= 35 ug/L

The capacity of the treatment system also has varied due to the normal wear and tear loss of efficiency and iron bacteria and silt fouling of the stripping towers. Though not indicated by the mid-fluent VOC analysis results, other 2006 operating factors (differential pressure between a tower air inlet and outlet and the air blower amperage) have indicated that tower 1 was becoming fouled and that the quantity of influent has had to be periodically restricted/reduced to preclude operational and/or mechanical damage to equipment. Both of the air stripping towers have been cleaned and repacked only once (July 1998) since the 1991 startup. This proved to be very effective but it was a costly effort. Also acid cleaning of the towers to restore the flow capacity lost due to fouling has been tried in the past, both before and after the 1998 repacking event (last time in October 2000), but this method has not been very effective and it is also almost as costly as cleaning and repacking. Thus a cleaning and replacement of the tower 1's packing materials (similar to whiffle balls) is currently under consideration to ensure that capacity of the treatment system does not adversely impact the effectiveness of the RA.

On-Site Recharge/Off-site Discharge - As discussed earlier in this document recharge basins were constructed at Site 2 and Site 3 to re-inject the treated groundwater with the objective of augmenting/increasing the natural soil flushing action that removes contaminants absorbed onto the soil in the vadose zone/above the groundwater level. The original design was to recharge 250 gpm with the remainder of the treatment system's capacity (70 gpm) being discharge to surface waters leaving the site (discharge point is Hanscom Field storm water discharge ditch flowing into Wetland B/beaver pond north of Hanscom field). However, as with the collection and treatment systems, iron bacteria growth in the recharge pipes restricted flow from the recharge pipes and recharging was stopped at Site 2 in January 1992 and at Site 3 in March 1992. Since 1992 there has been periodic recharging at both Site 2 and 3 as reflected in **Table 12** on the following page. Please note that since July 2001 the maximum rate possible has been recharged at Site 2 in an effort to flush out any residual contamination in the soil above the water table.

Table 12 – OU-1 Groundwater Remediation System Recharge System Data

	Average gpm								
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Off-site Discharge (gpm)	258.8	263.1	220.2	185.3	169.0	189.0	164.4	154.3	139.2
Site 2 Recharge (gpm)	10.1	0	10.4	7.5	6.2	8.5	10.4	6.2	2.8
Site 3 Recharge (gpm)	14.5	0	29.8	49.5	0	0	0	0	0
Calendar Year Total	283.5	263.1	260.5	242.3	175.2	197.4	174.8	160.5	142.0

Site 1 Source Area Vacuum Enhanced Recovery (VER) System: The VER system was initially installed and operated by Arcadis Geraghty & Miller as an AFCEE Technology Demonstration Project conducted in 2 phases; between December 1997 and June 1998 and between October 1998 and April 1999. **Figure 12** is a layout of the site and the components of the system include 4 recovery wells and a trailer outfitted with a 15 HP liquid ring vacuum pump to extract vapor and liquid (groundwater and/or DNAPL) from the recovery wells, a vapor/liquid phase separator, 2 granular activated carbon (GAC) units in series to treat the recovered vapor, and a pump with flow meter to transfer the recovered liquid to the Site 1 pump station for subsequent treatment by the central groundwater treatment facility. The 4 recovery wells are installed in a 40-ft square pattern with RAP1-3R in the center of the square. Each well was installed to specifically recover vapor and liquid from the bedrock fractures.

During the demonstration phases a total of 707,522 gallons of contaminated groundwater was recovered and processed by the central groundwater treatment facility. It was estimated that this system recovered an average of 2.4 pounds of VOCs per day that it operated, 1.4 via the vapor phase and 1.0 via the liquid phase. Due to the success of the demonstration the VER system was restarted on 28 April 1999 as a component of the OU-1 remedial action. The VER system subsequently operated continuously until 18 June 2001 (except for the period between 29 June 1999 and 22 October 1999 when high humidity made it impracticable to meet vapor phase discharge standards). During this period of operation a total of 1,323,232 gallons of contaminated groundwater was recovered.

At the time of the Second (2002) Five-Year Review the operation of the VER system had been suspended (on 18-June 2001) for the duration of a permanganate pilot study in the same area. The objective of this pilot study was to determine if permanganate injection/in-situ oxidation would be more effective than the VER system as a technology to use to clean up this source area. The field phase of the pilot study was completed in the fall of 2002 and part-time operation of the VER System commenced on 10-October 2002. It was concluded that both technologies were effective but that VER has a short-term advantage, due to its ability to actively draw the contamination to the recovery wells and the fact that the system was already in-place. It was also concluded that periodic permanganate injections should also be incorporated in the remediation strategy. Subsequently, around-the clock operation commenced on 24-December 2002 and continued until 31-July 2006 except for maintenance and repair periods. On 31-July 2006 operation of the VER system was again suspended for the duration of a permanganate treatment of the same area. A six-year summary of key operational data is presented in **Table 13** on the following page. It should be noted that, in addition to the permanganate suspension periods, major mechanical problems with the liquid-ring vacuum pump limited operation to less than 6-months in both 2003 and 2005. **Attachment C-11** is a chart of the VER system's monthly liquid effluent/discharge which graphically shows periods of shut downs and reduced operation since the initial startup/testing in October 1997.

Table 13 – Site 1 VER System Operational Data

	2001	2002	2003	2004	2005	2006
Gallons Processed	295,348	59,422	285,452	583,628	247,530	486,168
Average gpm	0.6	0.1	0.5	1.1	0.5	1.2
Vapor Influent – Ave VOCs - ppmv	185.2	Note 1	67.9	59.7	48.4	36.4
Liquid Effluent – Ave TCE - ug/L	1,754	Note 1	1,286	433	247	171
Liquid Effluent – Ave cis-1,2-DCE - ug/L	531	Note 1	498	212	185	111
Liquid Effluent – Ave cis-1,2-DCE - ug/L	531	Note 1	498	212	185	111

Note 1 – A representative calendar year average can not be calculated due to insufficient sampling & analysis during part-time operation 10-October – 24-December. Results for end of December 2002 samples have been included in the 2003 averages.

Attachment C-8 is a table that summarizes the VER system's operational data since the start of the permanganate injection pilot study in June 2001 through the 31 July 2006 shutdown for another permanganate injection period. This table includes the results of both the on-site and off-site laboratory analysis of the vapor stream as it flows through the treatment system. While this vapor data is collected to ensure that the treatment system complies with the vapor discharge criteria (at least 95% of the VOCs entering are removed before being discharge to the atmosphere) it also reflects the amount of VOCs being extracted from the subsurface in the vapor phase. **Attachment C-9** is a chart of annual average of the total VOC concentrations in the VER system's vapor phase for 2000 through the 31 July 2006 shutdown. Calendar year 2000 has been selected as the starting point for this chart as it was the last full year of operation before the permanganate pilot study (June 2001 through December 2002). This chart shows relatively constant levels in 2000 and 2001 prior to the shutdown. When the system was re-started following the permanganate injection phase the concentrations being recovered in the vapor phase were significantly reduced (~63%) and continued to slowing decline until the until the 31 July 2006 shutdown for another permanganate injection period

Please note that, the VER system is dual phase and contaminants are extracted from the subsurface in both a vapor phase and a liquid phase. However, the VER process transfers a significant amount of the recovered VOCs from the liquid phase to the vapor phase, thus the VER system's liquid effluent concentrations do not completely reflect the level of contamination being recovered in the liquid phase. There is a residual amount of VOCs retained in the liquid phase and **Attachment C-10** is a chart of the annual average TCE and cis-1,2-DCE concentrations (determined by the on-site GC analysis) in the liquid effluent from the recovery system from the start of the original demonstration project in December 1997 through the 31 July 2006 shutdown for another permanganate injection period. As shown in **Attachment C-10** the liquid effluent's concentrations were higher in the initial 6-month demonstration phase than in the second 6-month demonstration period. This decline was not fully explained but it is considered to be more the result of a declining operational efficiency due to improper adjustments of controls than depletion of contaminants available to be recovered. Subsequently when the system was incorporated as a component of the OU-1 RA the operational efficiency got

better over time and the annual average of the TCE and cis-1,2-DCE concentrations continually increased until the 2001 shutdown. Following the permanganate injection pilot study the trend reversed and the annual average of the TCE and cis-1,2-DCE concentrations continually decreased until the 2006 shutdown. This reversal is considered to reflect the effectiveness of the permanganate in destroying contaminants and the VER system effectiveness in reducing the amount of residual contaminants.

Attachments C-8 thru **C-11** appear to support that the combination of VER and permanganate injections have removed and destroyed a significant amount of the contaminants in the bedrock aquifer at the Site 1 source area. To better assess the residual level of contamination in the site's groundwater the VER system is periodically shutdown and, after a short period of time to recharge, the 4 recovery wells (VER RWs 1, 2, 3 & 4) are sampled and analyzed for TCE and cis-1,2-DCE concentrations with the on-site GC. As discussed earlier in this document these recovery wells are located in a confirmed DNAPL area. The wells are constructed to principally recover contamination from the bedrock fractures by using a very high vacuum to dewater the wells and volatilize the DNAPL. The results of this sampling and analysis show that there are wide fluctuations within each well and identification of trends is difficult. To better show the effect of the combined permanganate and VER efforts through June 2007 the average total of TCE and cis-1,2-DCE concentrations in the 4 recovery wells has been computed and plotted on the **chart** at **Attachment C-12.** January 2000 has been selected as the starting point for this chart to show the average total TCE and cis-1,2-DCE concentrations in the recovery wells before and after the permanganate pilot study. This chart shows that levels decreased significantly following the start of permanganate injections but that the levels started to rebound shortly thereafter and reached a rebound peak (lower than the pre-permanganate period) in September 2002. Subsequently levels dropped back and appear to have reached a plateau between 6,000 and 10,000 ug/L. However, the chart/**Attachment C-12** does appear to show that levels again decreased following the 2006 permanganate injection but additional post-injection monitoring following the resumption of VER in this area is required before the effects of the permanganate treatment can be fully assessed.

It is interesting to note that the VER area groundwater contamination based on the sampling and analysis of RAP1-3R in the center of the box (with the VER RWs at the corners) does not appear to be following the same decreasing trend found in the VER system's vapor and liquid effluent. The concentration of TCE in monitoring well RAP1-3R was 1,100,000 ug/L in June 1996, 152,600 ug/L in September 2001 and 142,000 ug/L in November 2006. While the pre-2001 reduction is significant (most likely due to the operation of the Site 1 VER system and/or permanganate injections) the relatively constant levels since 2001 are indicative of a DNAPL source in the vicinity of RAP1-3R which is not in the VER system's primary area of influence. In this regard the use of RAP1-3R VER recovery well during future operation of the VER system.

A hypothesis for the difference between VER operating data and the groundwater monitoring data the DNAPL source within the area of influence of the 4 recovery well is declining/

contributing less and less to both the vapor and liquid effluent contaminant levels but the system is also pulling in "dissolved" phase contaminants from a DNAPL source outside these well's area of influence. If this is the case the contaminant levels being recovered by VER will remain at current levels until all DNAPL in this source area is completely dissolved. The analytical data collected to date for the VER area indicates that progress is being made in reducing the mass of contaminants at Site 1 but that there is still a significant contaminant mass remaining outside the system's area of influence.

Source Areas Contaminant Concentrations: As stated earlier in this document, data initially collected for the OU-1 remedial action concerned the groundwater treatment facility's operation and compliance with discharge standards and did not include monitoring the contaminant concentration at individual collection sources. In 1997 it was realized that source data was needed to better optimize the OU-1 remedial system and the O&M program was revised to include the monthly analysis of samples collected from each of the 3 pump stations and from each BIW/IW. This analysis is performed by the O&M staff using an on-site gas chromatograph (GC). Note that only the 2 principal contaminants of concern (TCE and cis-1,2-DCE) are quantified during this on-site analysis. A discussion of the Collection System Point Source data follows. Please note Site 3 has been omitted because there has been no collection at this site since August 2001.

Site 1 Pump Station (Chart/**Attachment C-13**). This pump station's effluent is a composite of the discharge from the Site 1 collection trench, BIW-1, BIW-2, IW-6, IW-10, and the Site 1 VER system. IW-7/8/9 also discharge into this pump station, however, these wells were not operated much in the 2002-2006 time period. These collection system point sources, other than the collection trench, are also discussed separately. Since 2002 the Site 1 pump station's effluent TCE and cis-1,2-DCE concentrations have continued the decreasing trend noted in the 2002 Five-Year Review. The pump station effluent's TCE concentration has decreased from an average of 393 ug/L for 2002 to an average of 145 ug/L for 2006 and the cis-1,2-DCE concentration has decreased from an average of 93 ug/L for 2002 to an average of 35 ug/L for 2006. It is noted that since mid-2006 concentrations have been increasing but the TCE-CIS ratio remained constant over this period a little above 4. The recent increased is though to reflect a pocket of higher concentrations being "pulled" in from

Site 2 Pump Station (see Chart/**Attachment C-14**): This pump station's effluent is a composite of the discharge from the Site 2 collection trench, BIW #3, BIW #4, and IW-5. These sources, other than the collection trench, are also analyzed separately. Since 2002 the Site 2 pump station's effluent TCE and cis-1,2-DCE concentrations have continued the decreasing trend noted in the 2002 Five-Year Review but the concentrations are now approaching an asymptotic condition near the MCLs. The pump station effluent's TCE concentration has decreased from an average of 158 ug/L for 2002 to an average of 35 ug/L for 2006 and the cis-1,2-DCE concentration has decreased from an average of 270 ug/L for 2002 to an average of 98 ug/L for 2006. It is noted that the TCE-CIS ratio declined slightly over this period from 0.6 to 0.4 which indicates that biodegradation is a contributor to the cleanup of the groundwater in the Site 2 area.

As with the treatment system influent it appears that, if operating conditions remain the same, future decreases at Site 2 will take longer to materialize and be much less cost effective.

Site 3 Pump Station – as noted above active recovery from Site 3 was suspended on 22 August 2001 therefore there is no pump station data for this review period.

Boundary Interceptor Well Number 1 (BIW-1) (see Chart/**Attachment C-15**). This well is constructed to recover groundwater from the lower (glacial till) and bedrock aquifers. As noted in the 2002 Five-Year Review the TCE concentration being recovered was decreasing over time. Since 2002 BIW-1's effluent TCE concentration has continued to decrease but now appears to be at a plateau just under 100 ug/L. It is noted that cis-1,2-DCE concentrations are either below detection levels or at low levels which indicates that biodegradation is not a significant contributor to the cleanup in this part of OU-1. The hypothesis discussed for the VER system appears to be applicable for BIW-1, i.e., the groundwater contamination being recovered is the "dissolved" phase from a DNAPL source outside the well's area of influence and that TCE concentration will remain at current levels until that DNAPL is completely dissolved.

Boundary Interceptor Well Number 2 (BIW-2) (see Chart/**Attachment C-16**). This well is constructed to recover groundwater from the lower (glacial till) and bedrock aquifers. As noted in the 2002 Five-Year Review both the TCE and cis-1,2-DCE concentrations were on a downward trend and were very close to drinking water standard at that time. Since then the trends continued with TCE sometimes below detection levels and, since June 2005, the cis-1,2-DCE has consistently been below detection levels. In essence this well is no longer recovering significant contaminant mass and, on the surface, it would appear that its operation is no longer be necessary. However, BIW-2 contributes to the boundary's containment/capture zone and operation should be continued operation of as long as upgradient monitoring wells B126 (lower) and B243 (bedrock) and downgradient/off-site wells B2243 (lower) and B244A (bedrock) are above MCLs. Also it should be noted that, prior to reaching the current state, the TCE-CIS ratio had consistently been in the 0.2-0.4+/- range which indicated that biodegradation had been a contributor to the cleanup of the groundwater being captured by this well.

Boundary Interceptor Well Number 3 (BIW-3) (see Chart/**Attachment C-17**). This well is constructed to recover groundwater from the lower (glacial till) and bedrock aquifers. As noted in the 2002 Five-Year Review both the TCE and cis-1,2-DCE concentrations had declined significantly with a minor step up following a pump upgrade in 2001 (from the 1991 installed pump rated at 25-gpm to a pump rated at 50-gpm). It was also noted that cis-1,2-DCE concentration was usually below its MCL and that the TCE-CIS ratio was consistently in the 4.0+/- range. Since 2002 BIW-3's effluent TCE concentration has continued to decrease and is now approaching an asymptotic condition near its MCL whereas the cis-1,2-DCE concentrations have remained relatively stable below its MCL at ~ 40+/- ug/L. As with the treatment system influent it appears that, if BIW-3's operating conditions remain the same, future decreases will take longer to materialize and be much less cost effective. Also since the 2002 review the TCE-CIS ratio has decreased from > 1.0 to a 2006 average of 0.4 which is an indicator that

biodegradation is a contributor to the cleanup of the groundwater being captured by this well.

Boundary Interceptor Well Number 4 (BIW-4) (see Chart/**Attachment C-18**). This well is constructed to recover groundwater from the lower (glacial till) and bedrock aquifers. As noted in the 2002 Five-Year Review both the TCE and cis-1,2-DCE concentrations had peaked, and were on a significant downward trend. Since then the decreasing trends have continued though the TCE concentration appears to be leveling off at a level above its MCL. The TCE-CIS ratio has declined from > 2.0 in 1997 to < 0.2 in 2004 where it remains to the present. This is an indicator that biodegradation may be a significant contributor to the cleanup of the groundwater being captured by this well.

Interceptor Well Number 5 (IW-5) (see Chart/**Attachment C-19**). This well, constructed to intercept/recover groundwater contamination in the lower (glacial till) aquifer near the Site 2 source area, was added to the collection system in August 1997. As noted in the 2002 Five-Year Review both the TCE and cis-1,2-DCE concentrations rapidly declined following startup to a plateau at 500+/- ug/L each, However, between 2001 and the latter part of 2003, concentrations were in an increasing trend. Since peaking in 2003 both the TCE and cis-1,2-DCE concentrations have decreased significantly. Also of note is that the TCE-CIS ratio has been in a constant declined from the +1.0 range at the start of analysis to an average of 0.14 in 2006. This is an indicator that biodegradation may be a significant contributor to the cleanup of the groundwater being captured by this well.

Interceptor Well Number 6 (IW-6) (see Chart/**Attachment C-20**). This well, constructed to intercept/recover groundwater contamination in the bedrock aquifer near the Site 1 source area, was added to the collection system in August 1997. As noted in the 2002 Five-Year Review both the TCE and cis-1,2-DCE concentrations declined following startup to a plateau at 4,000+/- ug/L for TCE and 2,000+/- ug/L for cis-1,2-DCE. However, between 2001 and the latter part of 2003, concentrations were in an increasing trend. Since peaking in 2003 both the TCE and cis-1,2-DCE concentrations have decreased significantly (~ 50% +/-). Also the TCE-CIS ratio has consistently been in the 2.5+/- range. Normally a ratio in this range is considered an indication that biodegradation is not a significant contributor to cleanup, however, the level of cis-1,2-DCE being recovered by IW-6 does indicate that biodegradation is on-going in this part of OU-1.

Interceptor Wells Numbers 7, 8 & 9 (IWs-7, 8 & 9) (see Charts/**Attachments C-21, 22 and 23**). These 3 wells were originally installed as bedrock aquifer monitoring wells associated with the VER demonstration project and are shown on **Figures 11 and 12** as GM-97-M2, GM-97-M3 and GM-97-M4 respectively. They were converted to interceptor wells in April 1999 but, as noted in the Site 1 pump station discussion above, these wells were not operated after the 2001 permanganate injections in the VER area until late 2006. However, IWs-7 & 9 were used as permanganate injection wells in 2001 though IW-7 accepted very little. As shown in **Table 14** on the following page concentrations of both the TCE and cis-1,2-DCE in these wells were initially very high and declined rapidly following startup of the VER system and pumping from

these wells. Since the 2002 Review concentrations in these wells have fluctuated widely from one sampling to the next, however, through 31-July the average annual (semi-annual for 2006) concentration of both the TCE and cis-1,2-DCE continued to decrease. Semi-annual data is shown for 2006 to present the picture of levels before the VER was shut down for another permanganate injection for comparison to those following the VER shutdown and the subsequent re-activation of IW-7 and IW-8. This data also is a good indication that the VER captures contaminants that would normally flow through the area of IW-7 and IW-8. Also note that the cis-1,2-DCE concentrations may be an indicator that biodegradation is a contributor to the cleanup in this part of OU-1.

Table 14 – Site 1 VER Area - Average Annual Concentrations in IWs #7, 8 & 9

	IW #7		IW #8		IW #9	
	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE	TCE	cis-1,2-DCE
1998	7,562	2,291	96,000	bdl (<1,000)	43,740	bdl (<1,000)
1999	117,102	5,651	73,207	2,837	6,427	1,057
2000	19,955	2,383	6,495	2,098	4,354	1,432
2001	3,067	1,658	911	1,016	3,886	1,619
2002	3,136	1,855	1,594	1,233	119	61
2003	700	602	117	398	38	125
2004	616	321	126	386	19	87
2005	685	961	102	273	14	54
2006	134	119	529	518	15	49
Pre 31-Jul-06	68	38	8	143	15	67
Aug-Dec-06	244	249	1,398	1,143	15	19

While the average annual concentrations (which smoothes out the wide fluctuations) are a good indication of the effectiveness of the remedial actions at this Site 1 source area in capturing/ destroying contaminants, the Charts/ **Attachments C-21, 22 and 23**), which show the results of the individual sampling events, provide evidence that there continues to be an upgradient source.

IW-7 & IW-8 (Charts/**Attachments C-21 & C-22**) – The chart for IW-7 has a distinct pattern (typically significant summer/fall peaks of both TCE and cis-1,2-DCE) which is assumed to be an indication that a pocket of groundwater with higher contaminant concentrations is passing through the area. Though not as distinct as IW-7's chart the IW-8 chart also has similar periodic peaks. While groundwater movement in the vicinity of these wells may be accentuated when the system is operating the repeating peaks are more likely due to a significant rainfall that flushes out a pocket of contamination from an upgradient source which subsequently moves through the area. Additional data is needed to understand why these peaks are occurring.

IW-9 (Chart/**Attachment C-23**) – This chart also has a distinctive pattern (but of spring peaks for cis-1,2-DCE). However, since the 2001 permanganate injection in this well the contaminant levels (to include the spring time cis-1,2-DCE peaks) have been trending

down and are now approaching the MCLs. As with IW-7 and IW-8 the repeating peaks are probably due to a significant rainfall that flushes out a pocket of contamination from an upgradient source which subsequently moves through the area. Also the fact that the concentrations of cis-1,2-DCE being recovered by IW-9 usually exceeds the TCE is an indicator that biodegradation is on-going in this part of OU-1. Attempts will be made to rehabilitate and re-activate this IW to confirm whether not there is additional upgradient source(s) that could be captured by this well.

Interceptor Well Number 10 (IW-10) (see Chart/**Attachment C-24**). This well was added to the collection system in July 1999 and was constructed to intercept/recover groundwater contamination in both the overburden and bedrock aquifers (see **Figure 11**). It is located near the center of the Site 1 Burn Pit #2 (see **Figure 4**) and is considered to be outside the VER system's area of influence. The chart for IW-10 shows that the TCE concentrations have fluctuated without a discernable trend except for late spring/summer peaks. The data (table) also shows that the cis-1,2-DCE concentrations at this well are usually below detection levels which is an indication that there is no biodegradation underway. It does appear that a significant TCE source remains at this burn pit area. Unfortunately, due to high levels of silt and clay in the overburden and lack of significant fractures in the bedrock, the yield of this well is very low and completing the removal of the source under current conditions may take an extremely long time. Measures to enhance the yield of IW-10 and/or expedite the elimination of this source will be evaluated in the future.

Interceptor Well Number 11 (IW-11) (see Chart/**Attachment C-25**). This well is believed to be located near the center of the Site 1 on-site plume and is shown on **Figure 11** and **Figure 14** as IW-11 (IRZ-2). It was originally installed as a lower/glacial till aquifer monitoring well associated with the 2000-2002 demonstration project to create an in-situ reactive zone (IRZ) by the periodic injections of the molasses (see **Figure 13** for the IRZ Project's a site layout plan). In June 2006, following the conclusion of an extended post-molasses injection monitoring period, the monitoring well was converted to an interceptor well with the purpose to intercept/recover residual groundwater contamination and complete the cleanup of the IRZ area. Analytical results to date are insufficient to validate trends but as seen in Chart/**Attachment C-25** for IW-11 it appears that the amount of TCE being captured is remaining relatively constant whereas the cis-1,2-DCE appears to be increasing. Please note the LTM data discussed in following sections indicates that there is lingering positive effect for the IRZ created by the 2000-2002 injections of molasses and that most of the upgradient TCE has been/is being biodegraded near the injection well, leaving cis-1,2-DCE as the predominate contaminant remaining in the upgradient area. This is also confirmed by a low TCE-CIS ratio which has averaged of 0.11 since this IW-11 was put in serviced.

Data Review - OU-1 LTM Data

As discussed in earlier sections of this report the long-term monitoring of OU-1 was initiated in January 1986 and an extensive network of monitoring wells has been established to assess groundwater quality in each of the 3 aquifers of concern within OU-1. The OU-1 monitoring points are shown in **Figure 14**. The current LTM Plan is 2-phased; (1) the annual sampling of selected monitoring wells and a surface water sampling point for analysis of VOCs by an off-site commercial laboratory, and (2) the monthly/quarterly/semi-annually/annually sampling of selected monitoring and the surface water sampling point for analysis of TCE and cis-1,2-DCE by the O&M staff using an on-site GC. The table **at Attachment D** summarizes the laboratory VOC analysis of LTM samples since the initial monitoring in 1986. This table includes analytical data for the monitoring wells and surface water monitoring point in Phase 1 of the current LTM Plan. Additional data is available in the LTM Reports for OU-1 and the results of the on-site GC analysis which is included as an attachment to the monthly OU-1 Remedial Action Report. The table **at Attachment E** summarizes the 2002-2006 on-site GC results for LTM Phase 2 samples. Charts showing the long-term trends in the cis-1,2-DCE and/or TCE concentrations at OU-1 monitoring points are at **Attachment F**. Due to the complexity of the OU-1 groundwater contamination the analysis of results is best presented by the following sections of OU-1:

- Surface Water
- Site 1 Source Areas
- Site 1 On-site Plume except Hanscom AFB Campground area
- Site 2 Source Areas
- Site 2 On-site Plume and Hanscom AFB Campground area
- Boundary of Hanscom Field/Hanscom AFB with Town of Bedford Conservation Lands
- Off-site/ Town of Bedford Conservation Lands
- Site 3
- Northwest Area

Surface Water: The LTM surface water monitoring point is in the Hanscom Field storm water discharge ditch between Sites 1 and 2 which empties into Wetland B/beaver pond north of Hanscom field. This ditch also receives the groundwater treatment effluent that is not recharged on-site and the surface water monitoring point (RAP1-4SW) is located downstream of the treated effluent discharge point. As noted in the 2002 Five-Year Review both the TCE and cis-1,2-DCE concentrations had declined by 1999 to below 1.0 ug/L and, as shown in **Attachment F-1,** they continue to remain below 1.0 ug/L. These low levels can be attributed to the following: (1) the Site 1 collection trench is successfully containing any residual surface aquifer contamination at the source area precluding its migration to this downgradient location; (2) prior to the operation of the BIW's the drainage ditch received both surface runoff and the discharge from the surface aquifer. However, the operation of the BIWs and IWs has reversed the hydraulic gradients and the ditch recharges the surface aquifer with uncontaminated water. Following completion of all

active remedial efforts a period of LTM will be required with the hydraulic gradients back to normal in order to confirm the cleanup of the OU1 surface water.

Site 1 Source Areas: The Site 1 source areas are Burn Pit #1 (with an associated runoff area) and Burn Pit #2. These are shown on **Figure 4**. Burn Pit #1 is considered the major source of the contaminated groundwater plume migrating away from the site. There is no lacustrine layer at this location and it appears that the waste liquids poured into the pit, or flowing onto the runoff area, were able to make their way through the surficial glacial till and into the bedrock fractures underlying the site. Bedrock aquifer monitoring well RAP1-3R, at the downgradient edge of the runoff area and in the center of the VER area, is used to monitor progress towards elimination of this bedrock source. The historical TCE concentrations in this well are graphed in **Attachment F-2**. This chart indicates that progress towards reducing the Site 1 contaminant source has been made but that a significant amount remains. As discussed in the VER and IW-7/8/9 sections above, the reduction in TCE is most likely due to the combination of extraction by the Site 1 VER system; the in-situ destruction by permanganate; some (limited) removal by IWs-7, 8 and 9; and some biodegradation. Surface (glacial till) aquifer monitoring wells GM MW-1 (at pit/runoff area boundary) and RAP1-3S (adjacent to RAP1-3R in VER area) are used to evaluate the presence of a residual source in the surficial soils. As shown in **Attachment F-3 & 4** the TCE and cis-1,2-DCE concentrations in these wells fluctuate some but are now at relatively low levels indicating there is not a significant residual source in the surficial soils.

Burn Pit #2, while on the same Hartwell Hill plateau as Burn Pit #1, does appear to have a layer of lacustrine type soils above the underlying glacial till which is acting like a sponge and holding residual contamination. Monitoring well V-1 near the center of Burn Pit #2 is used to evaluate the presence of a residual source. As shown in **Attachment F-5** significant/fluctuating/declining levels of TCE were initially found in V-1 but, since mid-2004, concentrations have been relatively stable, averaging ~ 500 ug/L. This chart also shows that the cis-1,2-DCE concentrations at this well are usually below detection levels which is an indication that there is no significant biodegradation underway. When viewed in conjunction with IW-10 (which is adjacent to V-1) it does appear that a significant TCE source remains at this burn pit area.

Site 1 On-site Plume except Hanscom AFB Campground area: The Site 1 plume originally was cigar-shaped, extending in an easterly direction from the source areas (burn pits) on Hanscom Field to the vicinity of BIW-3 and BIW-4 in the Hanscom AFB Campground area. The Site 1 plume also co-mingles with the Site 2 plume in the Campground area. It is believed that the Site 1 plume generally follows a trough in the bedrock surface. Contamination had been found in all three aquifers with the greatest concentrations being in the bedrock and, as noted in the 2002 review, the Site 1 collection trench augmented by IW-6 in 1997 has been effective in capturing/containing the plume (surface, lower/glacial till and bedrock aquifers) flowing away from the source areas towards BIW-3 and BIW-4. It appears that this continues to be the case as the on-site GC results since the 2002 review have been relatively benign (low to bdl levels) for most of the monitoring wells between the source areas and Runway 23. Wells in this category

(with aquifer monitored noted) are: B103 (L), B237 (BR), B238 (S), B239 (L), CW-4 (L), PO1-4SA (S/L), PT1- SA (S/L), RAP1-2R (BR), and RAP1-5S (S). There are 2 exceptions, bedrock aquifer monitoring wells RAP1-5R and B240. As shown in **Attachment F-6** concentrations of both TCE and cis-1,2-DCE in RAP1-5R had declined significantly by May 1998 and each appeared to be at a steady state under 50 ug/L. However, starting in August 03 concentrations jumped up 1-2 orders of magnitude before falling back to 50 ug/L +/- each in September 06. This pattern is considered indicative of a pocket of groundwater with higher contaminant levels passing (or being pulled) through the area. In this location the Site 1 collection trench and IW-6 compliments/accentuates the natural groundwater flow direction. The 2nd exception is B240 which is a short distance downgradient of the collection trench/IW-6. As shown in **Attachment F-7** concentrations of both TCE and cis-1,2-DCE declined significantly following the 1997 startup of IW-6 and, prior to September 2006, had over a 4-year run when the cis-1,2-DCE was usually bdl and the TCE fluctuating between bdl an 50 ug/L. This indicates that B240 is within the capture zone of IW-6. Additional monitoring is needed to assess the late 2006 increases in both TCE and cis-1,2-DCE though it does appear that a pocket higher concentrations is being "pulled-back" through the area of B240 towards IW-6.

As noted in the 2002 review the OU-1 remedial action had been very effective in cleaning up the surface aquifer downgradient of the collection trench/IW-6 but less effective in cleaning up the cigar shaped plume in the lower/glacial till and bedrock aquifers in the downgradient area between the collection trench/IW-6 and BIW-3/BIW-4. However, it was evident that the BIWs were "pulling" the plume towards the boundary. Since 2002 the LTM data indicates that significant progress has been/is being made to also cleanup the lower and bedrock aquifers. 2 Monitoring well clusters (RAP1-6S/ RAP1-6T/RAP1-6R and RAP2-1S/RAP2-2T/RAP2-2R) which have been in the LTM Plan since Round 1 in 1986 are believed to be in the "cigar" and their LTM results document the effectiveness of the RA and progress towards cleanup. The RAP1-6 cluster is ~ 1/3 of the way from the source areas to BIW-4 and the RAP2-4 cluster is ~ 2/3's of the way.

The RAP1-6 cluster is also the area selected for the DoD molasses injection demonstration project (see **Figure 13**) with the lower aquifer injection well (IRZ-Inj) located ~ 50 feet upgradient of the cluster. 5 additional lower aquifer monitoring wells (IRZ-1 through 5) were also installed in this section of the Site 1 plume to monitor the effects of the molasses injections which occurred between October 2000 and October 2002. The RAP1-6 area was selected because lower and bedrock aquifer contaminant levels were still high and conditions in the lower aquifer were not considered conducive to the natural biodegradation of the groundwater contamination. The LTM results for the RAP1-6 cluster are shown in Charts/**Attachment F-8 (TCE) and Attachment F-9 (cis-1,2-DCE).** These charts show the dramatic and rapid cleanup of the surface aquifer following the 1991 start of the RA. They also show that, prior to the commencement of molasses injections, the cleanup the lower and bedrock aquifers was progressing at a very slow pace. Please note that, while the TCE-CIS ratio in the groundwater monitored by these wells was relatively low (0.30 +/-) indicating biodegradation, the data also

indicated that it was occurring upgradient of the RAP1-6 area and subsequently "pulled" to/through the area at relatively constant concentrations by the operation of the BIWs/natural groundwater flow. Since the last molasses injection in 2002 there has been a dramatic change in that both the TCE and cis-1,2-DCE concentrations in the lower aquifer dropped rapidly to the point that they join the surface aquifer as below MCLs. Concentrations of both in the bedrock aquifer have also declined significantly but still have a way to go.

As noted in the 2002 review and as shown in **Attachment F-8** the drop in the TCE concentration (both RAP1-6T and nearby IRZ-1 had significant/similar declines) in the lower aquifer after injections began in 2000 was considered a "localized" (or short term) effect of the injections. This conclusion was supported at that time by the data for the downgradient lower aquifer monitoring wells IRZ-2, IRZ-3, IRZ-4 and IRZ-5 which showed relatively stable concentrations. The LTM results for these IRZ wells are shown in Chart/**Attachment F-10**. In fact, as the effects of the injections wore off, some rebound in contaminant levels was expected and, as the post 2002 review results show, it did occur at both RAP1-6T and IRZ-1. However, the recent data also shows both a delayed and a lingering positive effect. It appears that the lower aquifer IRZ created by the 2000-2002 injections of molasses continues to be productive. Also, since 2003, the TCE and cis-1,2-DCE concentrations in the other/downgradient IRZ monitoring wells are in a definitive downtrend (Chart/**Attachment F-10**). Additionally, as shown the LTM chart (**Attachment F-11**) for the injection well, IRZ-INJ, an interesting/unique pattern has developed. As expected the TCE and cis-1,2-DCE concentrations dropped precipitously, and rapidly, during the active injection phase. Following the last injection, the cis-1,2-DCE initially rebounded to pre-injection levels, but is now in a definitive downtrend. However, the TCE has never rebounded. It has remained at very low to below detection levels since January 2001. It appears that the groundwater flowing into the IRZ area either is not longer contaminated or, if contaminated, all of the TCE in it has biodegraded by the time it reaches IRZ-INJ. The declining cis-1,2-DCE concentrations are also an indication that the overall levels of groundwater contamination flowing into the IRZ area is declining which supports the above discussion that the Site 1 collection trench augmented by IW-6 in 1997 has been effective in capturing/ containing the plume (surface, lower/glacial till and bedrock aquifers) flowing away from the source areas towards BIW-3 and BIW-4. Please note that the data for the IRZ wells is a combination of off-site laboratory and on-site GC analysis whereas only laboratory results are used for the RAP1-6 wells. As noted in the earlier discussion of IW-11 (formerly monitoring well IRZ-2) the monitoring period since the June 2006 startup of IW-11 is insufficient to assess it's impact on the groundwater flowing through the RAP1-6 cluster/IRZ-2 area.

Downgradient of the RAP 1-6/IRZ area and closer to BIW-4 is the RAP 2-2 monitoring well cluster (RAP2-1S, RAP2-2T, & RAP2-2R). These wells were originally installed to monitor the IRP Site 2 plume but are now believed to be in the Site 1 plume. The surface aquifer at this location (which had been cleaned up by 1994) is no longer a concern. In regards to the lower (RAP2-2T) and bedrock (RAP2-2R) aquifers an impact of the OU-1 remedial action is evident as shown in **Attachment F-12** and **Attachment F-13**. Contamination was not evident in the

bedrock aquifer and was at relatively low levels in the lower aquifer during the RI/prior to the RA. Following the start up of the BIWs in the early 90s concentrations began an increasing trend with the TCE peaking in both aquifers in July 2002. The cis-1,2-DCE concentrations peaked later than the TCE, however, as of the end of 2006, both the TCE and cis-1,2-DCE are in a definitive down trend. Also of note is that the pre-RA TCE-CIS ratio was <0.5 in both aquifers and has slowly declined to an average of <0.10 in 2006. This is an indicator that biodegradation may have been/is a significant contributor to the cleanup of the groundwater in this part of OU-1. Please note that the data for these wells is a combination of off-site laboratory and on-site GC analysis.

Also downgradient of the RAP 1-6 area but closer to BIW-2 and to the north of the "cigar" plume is the B-241 (surface), B-242 (lower) and B-243 (bedrock) monitoring well cluster. The surface aquifer at this location (which had been cleaned up by 1998) is no longer a concern and, since the 2002 review, the cleanup of the lower aquifer has progressed to the MCL for both TCE and cis-1,2-DCE by 2006 as shown in **Attachment F-14**. Progress, abiet slow, also continues in the bedrock aquifer but, as shown in **Attachment F-15,** levels are still above MCLs. The June 2006 activation of IW No. 11 and the August 2006 upgrade of the pump in BIW No. 2 are expected to expedite the complete cleanup of this area. Also of note is that the TCE-CIS ratio at the start of analysis (1996) was 0.4 and has slowly declined to an average of 0.14 in 2006. This is an indicator that biodegradation may be a significant contributor to the cleanup of the groundwater in this part of OU-1. Please note that the data for these wells is a combination of off-site laboratory and on-site GC analysis.

The above LTM results show that the OU-1 remedial action been effective in reducing the levels of contaminants in the Site 1 on-site plume (but that pockets of relatively high levels still remain). It is anticipated that continued operation of the dynamic groundwater collection, treatment and recharge system will result in the continued reduction in contaminant levels and ultimately eliminate the on-site plume attributed to the Site 1 source areas.

Site 2 Source Areas: The Site 2 source areas are drum burial pits within the area defined by the rectangular Site 2 surface aquifer collection trench. These features and the layout of the recharge basin constructed above the pits are shown on **Figure 5**. There is a lacustrine layer at this location and it appears that the waste liquids escaping from the buried containers were initially constrained by the lacustrine layer and were not able to readily make their way into the glacial till and bedrock fractures underlying the site. Contaminant levels in the surface aquifer are monitored by a line of monitoring wells installed diagonally across the source areas (**OW2-1 through OW2-7** from the northwest to the southeast while contaminant levels in the lower aquifer are monitored at **B115**, located in the center of the site. Please see **Figure 14** for these and other Site 2 monitoring locations.

The effectiveness of the collection trench has been confirmed by comparing the on-site GC results for surface aquifer monitoring well pairs **OW2-1/OW-2-2 and OW2-6/OW2-7** which are

located in the immediate vicinity of the collection trench with one well on the outside well and one on the inside. **OW2-1** is outside and **OW2-2** is inside the northwestern corner of the trench and **OW2-6** is inside and **OW2-7** is outside the southeastern corner of the trench. Historically, contaminant concentrations have been significantly higher in the wells located inside and, when "pockets" move into the inside wells, they do not show up in the outside wells. Since the 2002 review contaminant levels have remained relatively benign at all except **OW2-6**. As shown in **Attachment F-16** significant levels continue to move towards the collection trench in this area. On-site GC results also confirm that contaminant levels in other surface aquifer monitoring wells located near/outside the collection trench (**B-105, B-106**) or near the pump station (**OW2-8**) remain relatively benign which is a continuing confirmation of the effectiveness of the RA. The most significant surface aquifer contamination has historically been found in the center of the site at **OW2-4** and, as shown by **Attachment F-17,** there has been 2 distinct periods since monitoring began. Starting in 1994 (pre and early RA analytical results are not available for this area) the concentrations of TCE and cis-1,2-DCE declined significantly to below MCLs for each in 1999 and remained at the low levels until 2001. Subsequently levels climbed 1 to 4 orders of magnitude, peaking in 2003, before declining back down to near or below MCLs. This pattern is indicative of "pockets" passing/being pulled through the area on their way to the perimeter collection trench. This movement has also been confirmed by the 2006 on-site GC results for the other source areas surface aquifer wells (**OW2-3 & OW2-5**) which had significant spike-ups in 2006 (after the 2003 peak at OW2-4), especially for cis-1,2-DCE. Also of note the TCE-CIS ratio in these source area wells has consistently been <1 with cis-1,2-DCE being the predominant contaminant which is an indicator that biodegradation is on-going in the Site 2 source areas.

As stated above it has been assumed that the hazardous wastes released in the surface aquifer were not able to readily make their way into the glacial till because of the lacustrine layer underlying the Site 2 source areas. While not impermeable this layer does act as an aquitard. However, overtime there has been a "bleed" through of contaminants as shown by **Attachment F-18** which is the graph of the historical analytical results for lower aquifer monitoring well **B115** located in the center of the Site 2 source areas. Two factors contribute to the bleed through: (1) TCE is a sinker, i.e., heavier than water and (2) a reversal from a natural hydraulic up gradient to a down gradient caused by recovery from the lower/bedrock aquifers by the **BIW=3, BIW-4 and IW-5**. Unfortunately pre and early RA analytical results are not available for this area as the analysis of groundwater from **B115** did not commence until 1994. Since then concentrations of TCE and cis-1,2-DCE have very slowly declined though the cis-1,2-DCE concentration is still in the part per million range and has a way to go to reach its 70 ug/L MCL.

Site 2 On-site Plume to include the Hanscom AFB Campground area: As noted in the 2002 review and restated above the Site 2 collection trench had been very effective in capturing/ containing Site 2 surface aquifer contamination near the source areas. This continues to be the case and the downgradient surface aquifer in the Campground area is no longer a concern. The effectiveness of the RA in cleaning up the surface aquifer is best seen by review of the historical TCE concentrations in surface aquifer monitoring well **RWF-11** north of the source areas and

immediately (10 feet) downgradient of the collection trench. The results of the off-site/ commercial laboratory analysis of samples from this well are graphed in **Attachment F-19**. This chart shows a steady reduction in the TCE concentration from the pre-RA multi part per million levels found in the 80's-early 90's to approaching its MCL in 1996/7/8. Subsequently The TCE level jumped up in 1999 to be followed by another period of steady reduction and is again approaching its MCL. The cis-1,2-DCE concentration has followed a similar pattern but, except for the 1999 blip, has been less than it's MCL since the early 90's.

Also as noted in the 2002 review surface aquifer monitoring well **PO2-1S** located ~ 50 feet downgradient of the collection trench/RFW-11 was considered to be within the capture zone of the collection trench. If this hypothesis is correct then the post-2001 fluctuating/increasing concentrations of TCE as shown in **Attachment F-20** indicate that it is being "pulled back" to the trench. The fact that cis-1,2-DCE has been below detection levels in **PO2-1S** since 1997 supports the "pull back" hypothesis since the LTM data for the source areas and **RFW-11** shows that there is significant cis-1,2-DCE in the groundwater upgradient of **PO2-1S**.

As noted above contaminants have been making their way into the lower aquifer in the vicinity of the source areas (**B115**) which forms a plume in the lower aquifer flowing towards/being pulled to the north/northeast (and boundary) by the natural flow gradient accentuated by the operation of BIW-3 and BIW-4. It is also believed that the Site 2 plume co-mingles with the Site 1 plume in the lower aquifer in the Hanscom AFB Campground area. There are 4 lower aquifer monitoring wells north of the Site 2 source areas, 2 in the vicinity of the north side of the collection trench (**B109 & B114**) and 2 further to the north/downgradient in the Campground (**B108 & B113**). As noted in the 2002 review the Site 2 collection trench augmented by IW-5 in 1997 was effectively in cleaning up the lower aquifer in the vicinity of the Site 2 source areas but that up-trends were on-going in the Campground. Since the 2002 review progress continues to be made in cleaning up the source areas as evidenced by the earlier discussions for **IW-5** and **B115** and as shown in the Charts/**Attachments F-21 (B109)** and **F-22 (B114).** At **B109** there has been only minor spikes of the TCE concentration above its MCL while cis-1,2-DCE has remained (since 1998) at bdl. And, at **B114,** both TCE and cis-1,2-DCE concentrations are down-trending and approaching their MCLs.

In the Campground area the up-trends at **B108** and **B113** noted in the 2002 review and shown in the Charts/**Attachments F-23 (B108)** and **F-24 (B113)** appeared to have peaked during this review period and at the end of 2006 both the TCE and cis-1,2-DCE concentrations are trending lower in both wells. Also of note the TCE-CIS ratio in both wells have continued their long-term down-trend and are now $\leq$0.10, an indication that biodegradation is contributing to the cleanup of the lower aquifer in the Campground area.

Boundary: The boundary is defined by the four BIWs augmented by monitoring wells located along the boundary. The boundary monitoring wells in the lower aquifer and bedrock aquifer are listed below in order from the northwest to southeast the LTM charts found in **Attachment F** for

these wells are as follows:

RAP1-1T and RAP1-1R (immediately vicinity of BIW #1) – No Attachment F chart*
PT1-RA (between BIW #1 and BIW#2) – No Attachment F chart*
PO1-2R (between BIW #1 and BIW#2) -- **Attachment F-25**
RAP1-4RA (between BIW #1 and BIW#2) – No Attachment F chart*
B126 (lower) (immediately vicinity of BIW #2) -- **Attachment F-26**
PO2-1T and PO2-1RA (immediately vicinity of BIW #4) -- **Attachments F-27 & F-28**
PO2-2T and PO2-2R (immediately vicinity of BIW #4) -- **Attachments F-29 & F-30**
RAP2-1T and RAP2-1R (immediately vicinity of BIW #4) -- **Attachments F-31 & F-32**
RAP2-3T and RAP2-3R (between BIW #3 and BIW#4) -- **Attachment F-33****

* results are not charted as both TCE and cis-1,2-DCE have been found as low levels /below MCLs since 2002 Five-Year Review
** RAP2-3R results are not charted as the LTM laboratory has reported below detection levels for each S&A since 1997.

As noted in the 2002 Review the surface aquifer at the boundary and, as noted earlier, in the Campground area was considered no longer a concern. Thus there was no S&A of the surface aquifer wells along the boundary during the 2002-2006 period. Also, as noted in the 2002 Review, the LTM results for the lower and bedrock aquifer monitoring wells along the boundary (as augmented by the LTM results for the boundary interceptor wells) consistently reflected one of two patterns for the contamination in the lower and bedrock aquifers; either a declining trend since the start of data collection or an initial increasing trend followed by a declining trend. These patterns were considered a confirmation of the effectiveness of the four boundary interceptor wells in containing/capturing lower and bedrock aquifer contamination at the boundary while also pulling back from the off-site area of concern. Since 2002 progress towards cleanup has continued as evidence by the referenced charts and the following **Table 15** compares the November 2001 LTM results for the boundary monitoring wells to the recent November 2006 results. These results are segregated by aquifer and listed in order from the northwest to southeast.

Table 15 – OU-1 LTM Data for the Hanscom Field/Off-site Boundary

	TCE - ug/L		cis-1,2-DCE- ug/L		TCE-CIS Ratio	
	2001	2006	2001	2006	2001	2006
RAP1-1T (lower)	ns/dry	0.46	ns/dry	bdl	unk	n/a
B126 (lower)	**8.4**	**12.9**	3.79	6.21	2.22	2.08
PO2-1T (lower)	**15**	**5**	**894**	**171**	0.02	0.03
PO2-2T (lower)	**441**	**83/55**	**248**	**280/240**	1.78	0.30/0.23
RAP2-1T (lower)	**5.1**	3.90	33.5	**257**	0.14	0.20
RAP2-3T (lower)	**91.6**	1.88	**86.1**	35.7	1.06	0.05
RAP1-1R (bedrock)	0.2	0.22	bdl	bdl	n/a	n/a
PT1-RA (bedrock)	bdl	bdl	22	bdl	n/a	n/a
PO1-2R (bedrock)	**19.5**	**5.34**	0.47	0.88	41.5	6.07
RAP1-4RA (bedrock)	2.0	1.26	0.66	0.77 3.03	1.64	
PO2-1RA (bedrock)	3	3	**247**	31	0.01	0.10
PO2-2R (bedrock)	**96**	**85**	63	**253**	1.52	0.34
RAP2-1R (bedrock)	**265**	**130**	**278**	**160**	0.95	0.81
RAP2-3R (bedrock)	bdl	bdl	bdl	bdl	n/a	n/a

Note: Bolded results exceed the MCL

The above table show that the most significant remaining contamination is in the vicinity of BIW-4. The above also reflects that cis-1,2-DCE is becoming more predominate than TCE which is an indication that biodegradation is on-going in the groundwater being pulled towards BIW-4. Please note that PO2-1T/PO2-2RA is west of BIW-4, RAP2-1T/RAP2-1R is east, and PO2-2T/PO2-2R is south. A comparison of the average annual TCE and cis-1,2-DCE concentrations (based on monthly on-site GC analysis of samples) being captured by the 4 BIWs in 2002 versus 2006 is presented in **Table 16** on the following page. Also note these results are *listed in order from the northwest to southeast.*

Table 16 – Average Annual Contaminant Levels Captured by the BIWs (GC Data)

	TCE - ug/L		cis-1,2-DCE- ug/L		TCE-CIS Ratio	
	2001	2006	2001	2006	2001	2006
BIW-1 (lower/bedrock)	111	84	0.4	1.5	278	56
BIW-2 (lower/bedrock)	21	6	87	bdl	0.24	n/a
BIW-4 (lower/bedrock)	435	44	918	324	0.40	0.14
BIW-3 (lower/bedrock)	107	14	28	46	3.82	0.30

Of note is the data for RAP1-1T, RAP1-1R and BIW-1 which are located on the northwestern end of the Hanscom Field/Hanscom AFB boundary with the Town of Bedford. At this location

there is no lacustrine layer to separate the surface from the lower aquifer thus RAP1-1T monitors both aquifers and, except for 5.6 ppb in November 1994, the TCE levels have been and continue to be below drinking water standards. Also, as of June 1996, TCE levels in the bedrock in RAP1-1R decreased to 5.5 ppb and have been below drinking water standards ever since. Also note Cis-1,2-DCE has always been below detection levels in both of these wells. However, as discussed earlier in the Collection System Point Sources Contaminant Concentrations section significant TCE concentrations (100+/- ppb) continued to be capture by the nearby BIW-1. This is most likely due to fact that the BIW is much deeper into the bedrock than the monitoring well and is pulling the TCE through deeper fractures than those monitored by RAP1-1R. The total depth of BIW-1 is 95 feet whereas the depth of RAP1-1R is 54.4 feet. The source of the contamination being captured by BIW #1 has never been confirmed. It may be from IRP Site 1, however, the modeling completed as part of the Feasibility Study does not reflect this. Regardless of the source the fact is that the contamination is being captured by BIW-1 and Hanscom AFB has no plans to stop recovery by BIW-1 before a "Response Completed" status is reached for OU1 or a Technical Impracticability (TI) Waiver for all or part of OU1 is issued with no requirement to operate BIW-1. However, operation of BIW-1 will be suspended followed by a LTM phase if/when contaminant concentrations being captured fall below the MCLs.

Off-site/Town of Bedford Conservation Lands: The off-site plume in the Bedford Town Forest is monitored by four (4) monitoring well clusters. Also an on-site/boundary well couplet is also included in the grouping as it is downgradient of BIW-4. These wells and their respective LTM chart/Attachment F document number are as follows:

B127 (surface) & B111 (lower)-approximately 250' north of BIW-4 - **Attachment F-34***

B244A (bedrock), B245 (lower) & B246 (surface) – south/west flank of plume, approximately 550' northeast of BIW #2 -- **Attachment F-35**

B247 (surface), B248 (lower) & B249 (bedrock) – near the center of plume, approximately 900' north of BIW #4 – **Attachments F-36 & F-37**

B250 (surface), B251 (lower) & B252 (bedrock) – south/east flank of plume, approximately 450' east of BIW #4 -- **Attachment F-38**

B253 (surface), B254 (lower) & B255 (bedrock) – near the leading edge of plume, approximately 2,000' north of BIW #4 -- **Attachment F-39**

* results are not charted for B127 as both TCE and cis-1,2-DCE have been at low levels /below MCLs for several year before the 2002 Five-Year Review

The pre-2002 LTM analytical data had established that the surface aquifer in the off-site/Bedford Conservation Lands met drinking water standards (MCLs) and there was no sampling and analysis of the surface aquifer during the 2002 -2006 review period. The 2002 review also noted that contamination in the lower aquifer was much more significant than in the bedrock aquifer, suggesting that the primary migration pathway is in the lower aquifer. This was consistent with the modeling discussed in the Basis for Action section. During the 2002-2006

period progress continued to be made in reducing the overall strength of the off-site plume as shown on the above referenced charts and as documented in **Table 17** below. This progress can be attributed to the containment/capture zone at the boundary resulting from the operation of the BIWs which both precludes the further feeding of the off-site plume while also pulling some of it back to the capture zone. This allows for the natural attenuation of the remainder of the plume and biodegradation does appear to be on-going as evidenced by the TCE-CIS ratio data. Please note the spike-up in cis-1,2-DEC at B-111 and the significant downtrend (especially in the TCE concentrations) in the cluster in the center of the off-site plume (B247, B248 and B249). These results are a good confirmation that the BIW's are also pulling back some of the off-site contamination.

Table 17 – OU-1 LTM Data for Off-Site Monitoring Wells (in Bedford)

	TCE - ug/L		cis-1,2-DCE- ug/L		TCE-CIS Ratio	
	2001	2006	2001	2006	2001	2006
B111 (lower)	**9.3**	**7.4**	29.3	**102**	0.32	0.07
B245 (lower)	**9.5**	4.6	23.7	35.1	0.40	0.13
B248 (lower)	**262**	**15**	**153.9**	**120**	1.70	0.13
B251 (lower)	**17.5**	1.68	18.4	4.56	0.95	0.37
B254 (lower)	**23.1**	**8.86**	4.28	25.3	5.40	0.35
B244A (bedrock)	**44**	**16.4**	**72**	50.2	0.61	0.33
B249 (bedrock)	**9.9**	1.43	0.74	0.20	13.4	7.2
B252 (bedrock)	0.2	bdl	bdl	bdl	n/a	n/a
B255 (bedrock)	bdl	bdl	bdl	bdl	n/a	n/a

Note: Bolded results exceed the MCL

The LTM results for the off-site area in conjunction with the LTM results for the boundary interceptor and monitoring wells indicates that the OU-1 RA has been, and continues to be successful in containing/capturing lower and bedrock aquifer contamination at the boundary while also reducing the strength of the off-site plume.

Site 3: As noted in the 2002 review the groundwater in the lower and bedrock aquifers at Site 3 consistently met drinking water standards and, at those lower and bedrock aquifer monitoring wells that had positive detections of TCE and/or Cis-1,2-DCE, the trend in concentrations was down. This situation continued throughout the 2002-2006 period and the lower and bedrock aquifers at Site 3 are no longer considered to be a concern. Please note that charts have not been presented/considered meaningful for the Site 3 lower and bedrock aquifer monitoring wells since all results are either close to or below detection levels.

In regards to the surface aquifer (and as discussed previously) LTM data presented in the 2002

review showed that the remedial action has been very successful in cleaning up the surface aquifer and that the collection, treatment and recharge of groundwater at IRP Site 3 had been stopped in August 2001. However, this August 2001 shutdown of the Site 3 groundwater recovery, treatment and recharge was considered an interim action until future long-term monitoring results confirm that no further active cleanup is required for IRP Site 3. Subsequently, monitoring during the 2002-2006 period has documented that the surface aquifer at the Site 3 source area within the capture zone of the collection trench continues (with a few on-site GC exceptions) to meet the MCLs/drinking water standards. The impact/continued effectiveness of the remedial action is shown in **Attachment F-40** for the surface aquifer monitoring well, OW3-7, located in the center of the Site 3 source area (drum burial pits) and in **Attachment F-41** for the surface aquifer monitoring well, B118, located a short distance downgradient of the collection trench. There has been periodic/random on-site GC results which exceed the MCL of 5 ug/L for TCE and 70 ug/L for cis-1,2-DCE. Quite a few of these are considered "suspect" (or false positives) as the results were just above or below the GC's method detection levels. It is planned to re-commence the collection, treatment and recharge of groundwater at Site 3 for a short (~3-month) period to confirm whether or not there is any **residual** soil or groundwater contamination remaining within the perimeter of the collection trench.

In addition to the Site 3 source area within the capture zone of the collection trench, there are 2 additional areas in the Site 3 area that have had/have significant surface aquifer contamination. One is the location of surface aquifer monitoring well RAP3-3S. This well is downgradient of historical drum burial pit 3J which is not within the perimeter of the Site 3 collection trench. It is approximately 250 feet to the east and is considered to be outside of the collection trench's capture zone. LTM data for RAP3-3S is shown in **Attachment F-42**. While this graph shows wide fluctuations, the overall TCE concentration is believed to be trending lower. Also the TCE-CIS ratio continues to be much greater than 1.0 (averaged 10 for 2002-2006) which is an indication that biodegradation is not significant at this location. Measures to enhance the biodegradation and thus accelerate the cleanup of this, the final hotspot at Site 3, are under consideration at this time. The second area of concern, albeit a decreasing concern, is the location of surface aquifer monitoring well RAP3-4S. A source of the groundwater contamination is this area has never been found and, as at RAP3-3S, this area is considered to be outside the collection trench's capture zone. As shown in the chart/**Attachment F-43** for RAP3-4S the TCE concentrations peaked in 1990 and, in November 1999 and November 2000, declined to below its MCL/Drinking water standard of 5 ug/L. Since then there was a slight increase to above before falling back below its MCL in November 2005 and November 2006 with an average concentration of <6.5 ug/L for 2002-2006. Unlike the RAP3-3S area there appears to be significant biodegradation at the RAP3-4S location as evidence by an increasing trend for cis-1,2-DCE to the point that it exceeded its 70 ug/L MCL in November 2004 and again in November 2006. Also the TCE-CIS ratio average for 2002-2006 was <0.2. Of note the TCE and Cis-1,2-DCE concentrations in the lower aquifer wells at both of these areas of concern (RAP3-3T and RAP 3-4T) have never exceeded drinking water standards. Also of note is that

Site 3 to include the two isolated surface aquifer areas of concern are on the upgradient side of the OU1 boundary capture zone and that natural attenuation/dispersion without active remediation should be protective of human health and the environment going forward.

Northwest Area: Please note that this area was included in the Haley & Aldrich's investigation of Hanscom Field Area to confirm whether or not groundwater contamination was migrating from Hanscom Field towards Elm Brook on the north side of Hartwell Hill. The investigation concluded that it was not and LTM data at the time of the 2nd Five-Year Review confirmed that groundwater throughout the Northwest area met drinking water standards and that no further action in regards to the Northwest area was warranted.

Data Review OU-2/IRP Site 4

Since the first Five-Year Review conducted in 1997, OU2/IRP Site 4 has been in a long-term maintenance phase with no requirement for groundwater or surface water monitoring. The first Five-Year Review did identify a requirement for maintenance of the site to remove scrub brush growing in the drainage ditches and on sections of the cap. This maintenance was completed in the spring of 1998. Subsequently, since 1999, quarterly inspections have been routinely performed and maintenance/repairs identified in the inspection have been completed. Review of the quarterly inspection reports issued by the Base's Environmental Protection Services contractor, MaraTech Engineering Services, Inc. since the 2nd Five-Year Review in 2002 confirms that the integrity of the cap is being maintained and that there are no physical changes at the site.

Data Review OU-3/IRP Site 6

Long-term Maintenance and Inspection: As a result of the RA construction activities the RAOs for this site have been substantially achieved and in September 2001 the Site entered the long-term maintenance and monitoring phase. Review of the quarterly inspection reports issued by the Base's Environmental Protection Services contractor, MaraTech Engineering Services, Inc. since the 2nd Five-Year Review in 2002 confirms that the integrity of the cap is being maintained and that there are no physical changes at the site.

Wetland Mitigation Monitoring: As noted earlier a Five Year Monitoring Plan for the wetland areas remediated during the construction phase of the Site 6 Remedial Action was initiated in September 2001 and concluded with a fall 2006 Wetland Mitigation Monitoring event by Shaw Environmental, Inc., subcontractor to the Base's Environmental Protection Services contractor, MaraTech Engineering Services, Inc. The Wetland Mitigation Monitoring Reports issued by Shaw documents the successful conclusion of the Five-Year Monitoring Plan specified by the Remedial Design. The monitoring data presented in this report clearly indicate that the wetlands have exceeded the design goal for vegetative cover, and provide ample evidence that wildlife habitat has been restored. The Remedial Design also specified that the initial Five-Year Monitoring should be followed by a Long-Term Monitoring Plan for continuing evaluation of the

restoration every 5 years. Therefore the next formal monitoring event (an ecosystem evaluation of the restoration areas) will be programmed to be completed in June 2011.

Groundwater/Surface Water and Compliance Boundary Monitoring: The long-term monitoring of OU-3/IRP Site 6 commenced with a "baseline" event on December 2001 following completion of construction activities. Since then an annual round of sampling and off-site commercial laboratory analysis has been conducted with the most recent in October 2006.

The initial LTM Plan for Site 6 was to collect 1 to 3 rounds of samples that were analyzed by an off-site commercial laboratory for VOCs, SVOCs, pesticides, PCBs and metals (by EPA methods 8260B, 8270C, 8081A, 8082, and 6010B respectively). The results from this 1 to 3 round effort were then used to identify CoCs at each well location and to refine future sampling and analysis requirements for annual rounds and to support five-year reviews. A supplemental LTM event was conducted in the spring of 2003 to collect samples from wells that were dry when the 2001 and 2002 annual events were conducted in the fall. Also, commencing in July 2005, a quarterly event has been conducted to collect seasonal dissolved arsenic data. A network of monitoring points (which has been developed over time) as shown in **Figure 8** is used to assess Site 6's surface water and groundwater and the analytical results of the analysis of the LTM groundwater and surface water samples are formally documented in Long-Term Monitoring Reports. Tables are included in each LTM Report which summarizes all LTM exceedances of a standard and **Table 3-7** (surface water/AWQC) and **Table 3-8** (surface water and groundwater/MCLs and MCP GW-1 & 2) from the 2006 LTM Report are presented as **Attachment G-1 and Attachment G-2 respectively.**

Since the landfill waste has been left in place is not expected that the groundwater under the wastes would meet drinking water standards and the purposes of the monitoring component of the RA is to identify the on and off site's post-RA CoCs, to monitor changes in on-site contaminant concentrations over time, and to confirm that CoCs are not migrating off-site towards the groundwater compliance boundary (which is also a component of the RA). The LTM data collected to date confirms that (while there are on-site hot-spots of VOCs/SVOCs, a pesticide (4-4'-DDD), a PCB (aroclor 1242), and some metals (barium, cadmium and nickel)) dissolved arsenic is the only on-site CoC that is also found in the vicinity of the groundwater compliance boundary established in the off-site area downgradient of the former filter bed area. **Table 18** on the following page summarizes the of post-RA dissolved arsenic results from the baseline monitoring event through the quarterly dissolved arsenic samples collected in April 2007.

TABLE 18 - IRP SITE 6 GROUNDWATER ANALYSIS for DISSOLVED ARSENIC

The following is a summary of all post-RA analysis for dissolved arsenic. Exceedances of the 10 ug/L MCL are shaded

Well No.	Aquifer	Dec-01	Oct-02	Apr-03	Sep-03	Oct-04	Apr-05	Jul-05	Oct-05	Jan-06	Apr-06	Jul-06	Oct-06	Jan-07	Apr-07
Filter Bed Area Southern Boundary/Base of South & West Landfill Areas - Listed in order from West to East															
MW6-113U	Surface	NS - DRY	NS - DRY	11 F	9 F	3 F	NS	NS	2.41 F	NS	NS	NS	<20	4.7	
MW6-113T	Lower	< 2.7	<1.6	2 F	<2.9	<2.5	NS	NS	<1.86	NS	NS	NS	<20/<20	<4	
MW6-103	Sur/Lac	NS - DRY	NS - DRY	6 F	NS	13 F	NS	NS	27	NS	NS	NS	NS	9.7	5.2
MW6-23	Lacustrine	62	11 F	NS	15 F	8 F	NS	NS	10	NS	NS	NS	6.6	NS	
MW6-11	Lower	45	50	NS	< 2.9	<2.5	NS	NS	<1.9	NS	NS	NS	<4	NS	
MW6-13	Lower	12 F	NS	20 F	<2.9	23 F	NS	NS	9.6	NS	NS	NS	7.4	NS	
MW6-104	Sur/Lac/Low	NS - DRY	NS - DRY	10 F/14 F	NS	NS - DRY	18	NS		NS	NS	NS	NS	6.9	7.2
MW6-111T	Lower	< 2.7	NS	NS	NS	25 F	NS	NS	72	NS	NS	NS	76	NS	64
Filter Bed Area Northern Boundary - Listed in order from West to East															
MW6-114T	Lower	< 2.7	<1.6	NS	<2.9	NS	NS	NS	NS	NS	NS	NS	NS	NS	
MW6-105	Sur/Lac	NS - DRY	27 F	NS	12 F	30/30	NS	NS	37	NS	NS	NS	10	NS	<4
MW6-17	Surface	6 F	60	NS	122	105	NS	72	35/19	6.6	22	NS	86	4.6	37
MW6-B09	Lower	26 F	15 F	42	36	46	54	51	34	52	50	NS	52	54	46
MW6-110U	Surface	< 2.7	NS	<1.6	<2.9	<2.5	NS	NS	2.74	NS	NS	NS	<4	NS	
MW6-110T	Lower	22 F	23 F	NS	21 F/23 F	10 F	NS	NS	22	NS	NS	NS	18/18	NS	17/18
PZ-W								19	20.7	22	9.8		13.3	6.3	9.1
MW6-112U	Surface	< 2.7	<1.6	<1.6	<2.9	<2.5	NS	NS	<1.86/<1.86	NS	NS	NS	<4	NS	
MW6-106	Surface	NS - DRY	<1.6	NS	< 2.9	<2.5	NS	NS	<1.9	NS	NS	<1.2/<1.2	<4	<4	
MW6-22	Lacustrine	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.67	NS	NS	
MW6-B07	Lower	48	NS	46	50	44/45	NS	NS	43/43	NS	NS	63.4	55	61/61	89
PZ-E								16	59.4	7.5	7.2	19.1	47.2	32	15
North of Site - Arsenic Hotspot															
MW6-16	Surface	< 2.7	<1.6	NS	66	18 F	<2.5	<2.5/<2.5	2.0 F/2.4 F	<1.9	<1.9	NS	<4	<4	<4
MW6-B10	Lower	21 F	40/35	NS	43	51	NS	51	48	52	55	NS	55	62	54
MW6-21	Surface	6 F	32	<1.6	5 F	35	<2.5	80	170	2.8 F	<1.9	35	99	7.1	<4
MW6-25	Lacustrine	123/90	<1.6	2 F	4 F	20 F	3 F	<2.5	3.4 F	<1.9	<1.9	NS	<4	<4	<4
MW6-15	Lower	< 2.7	18 F	<1.6	<2.9	4 F	<2.5	<2.5	<1.9	<1.9	<1.9	NS	<4	<4	<4
MW6-118U	Surface		24 F	23 F	108	179	14/20	90	39	2.8 F/<1.9	28	48	200/200	28	32
MW6-118T	Lower		<1.6	<1.6	<2.9/<2.9	<2.5	NS	NS	<1.9	NS	NS	NS	<4	NS	<4
Proposed Compliance Boundary - Listed in order from West to East															
MW6-115T	Lower	NS	<1.6	NS	<2.9	<2.5	NS	NS	NS	NS	NS	NS	NS	NS	
MW6-18	Lacustrine	< 2.7	3 F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
MW6-12	Lower	< 2.7/< 2.7	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
MW6-116U	Surface		<1.6	<1.6	<2.9	<2.5	NS	NS	<1.9	NS	NS	<1.2	<4	NS	
MW6-116T	Lower		<1.6	<1.6	<2.9	<2.5	NS	NS	<1.9	NS	NS	NS	<4/<4	NS	
MW6-119U	Surface	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	8	33	<4/<4	<4
MW6-120U	Surface	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	11/11	9	<4	<4/<4
MW6-117U	Surface		5 F	4 F	6 F	8 F	3 F	3.0	16	<1.9/<1.9	3.5 F/2.5 F	3.0 F	9.9	<4	<4
MW6-117T	Lower		<1.6	<1.6	<2.9	<2.5	NS	NS	<1.9	NS	NS		<4	NS	<4
MW6-121U	Surface	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<1.2	6.7	<4	<4
MW6-14	Lower	NS	<1.6	NS	<2.9	<2.5	NS	NS	NS	NS	NS	NS	NS	NS	
Debris Excavation Area No. 1 - East of Filter Bed Area															
MW6-122U	Surface	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<1.2	<4	NS	
MW6-122L	Lacustrine	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<1.2	<4	NS	
MW6-122T	Lower	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	<1.2	<4	NS	
Surface Water															
SW6-05		< 2.7	<1.6	<1.6	<2.9/<2.9	NS	<2.5	<2.5	<1.9	<1.9	<1.9	<1.2	<4	NS	

< less than method detection limit
F - Between method detection limit & the reporting limit
Primary/Duplicate
NS - Not Sampled
Exceeds MCL of 10-ug/L (ppb)

The LTM data also appears to indicate that there is still some on-going "flushing" of CoCs from the landfill waste to the groundwater as evidenced by fluctuating concentrations some of the SVOCs and metals. Also, especially in regards to VOCs, there does appear to be some natural attenuation with concentrations of benzene, 1,4-dichlorobenze, and TCE slowly decreasing. The last exceedance of the MCL for benzene was in the April 2003 LTM event and the last exceedance of the MCL for TCE was in the December 2001 baseline LTM event. 1,4-dichlorobenze, a compound which bridges the VOC – SVOC analytical boundary, appears to be more persistent but its concentrations are trending slightly lower. Of the on-site SVOCs exceeding the standards the most significant are the pentachlorophenol (PCP) and its breakdown compounds found in the surface aquifer monitoring well MW6-106.

As discussed earlier in this document a monitoring well cluster (surface aquifer, lacustrine aquifer & lower/till aquifer) was installed in May 2006 in the area to the east (Debris Excavation Area No. 1 on the site plan) to assess the water quality it that area. These wells (identified as MW6-122U, MW6-122L and MW6-122T on **Figure 8**) were initially sampled in July 2006 and all samples were analyzed for all of Site 6's CoCs (VOCs, SVOCs, pesticides, PCBs, and dissolved metals). With the exception of one questionable estimated result for thallium (a metal) the initial sampling and analysis did not identify any CoC in the former Debris Excavation Area (DEA) No. 1. Thus future LTM analysis will be limited to SVOCs and dissolved arsenic which are the principal CoCs for Site 6. EPA Method (6010B) used by the laboratory for the initial metal analysis is not the best method to quantify low levels of thallium since false positive results are sometimes reported. To determined whether or not thallium is to be added as a CoC for Site 6 the DEA No. 1 cluster will be re-sampled in the October 2007 LTM event and analyzed for thallium using Method 7841 (which has a method detection level of 0.8 parts per billion).

The LTM Plan for OU-3/IRP Site 6 includes the sampling and analysis of the surface water from a small stream flowing from the wetlands and ponded area north of the former filter bed area. Surface water monitoring point SW6-05 in the stream has been used for this monitoring and samples were analyzed for all of Site 6's CoCs (VOCs, SVOCs, pesticides, PCBs, and dissolved metals). This surface water has always met the AWQC for all constituents except for a one-time exceedance of the iron criteria in October 2002. Also this surface water has consistently met the drinking water standards.

The LTM Plan for OU-3/IRP Site 6 includes the sampling and analysis of the monitoring wells in the vicinity of a designated groundwater compliance boundary to confirm that the groundwater outside the boundary meets drinking water standards (MCLs). The initial sampling and analysis of groundwater at existing monitoring wells selected to help define the post-RA groundwater compliance boundary was included in the 2001 baseline monitoring event. However, as The LTM Plan for OU-3/IRP Site 6 includes the sampling and analysis of monitoring wells in the vicinity of a designated groundwater compliance boundary to confirm that the groundwater outside the boundary meets drinking water standards (MCLs). The initial sampling and analysis of groundwater at existing monitoring wells selected to help define the post-RA groundwater compliance boundary was included in the 2001 baseline monitoring event. However, as

discussed earlier in this document, the installation of three additional monitoring well couplets down gradient from Site 6 on adjacent landowner's property to better define the groundwater compliance boundary was delayed and not completed until September 2002. The initial sampling and analysis of groundwater from these wells was included in the October 2002 LTM event for Site 6. In 2005 after a review of the LTM data collected to date (**Attachment G-1, G-2 and Table 18)** it was concluded that there is a pocket dissolved arsenic which exceeds the arsenic MCL (10 ug/L) in the surface aquifer further downgradient of the site than anticipated and that the compliance boundary as proposed in the ROD should be moved further to the north, near the Shawsheen River. The expanded compliance boundary, to include three additional surface aquifer monitoring wells (which were installed in 2006) to better define the revised compliance boundary, is shown on **Figure 8**. These additional wells were initially sampled in July 2006 and subsequently included in the quarterly LTM events which are being conducted to evaluate seasonal changes/impacts in the off-site dissolved arsenic plume. Review of **Table 18** indicates that there are wide swings in the dissolve arsenic concentrations found in surface aquifer monitoring wells whereas concentrations in the lower aquifer monitoring wells are relatively constant. In general the dissolved arsenic concentration in the groundwater samples collected from the monitoring wells being used to define the compliance boundary meets the drinking water standards. However, there has been a one-time exceedance in MW6-117U (16 ug/L in October 2005), a one-time exceedance in MW6-119U (33 ug/L in October 2006), and a one-time exceedance in MW6-120U (11 ug/L in July 2006). Base on this data additional data/time is required to confirm that the Site 6 Groundwater Compliance Boundary (which was revised/expanded further to the north in 2006) adequately defines where the dissolved arsenic concentrations are less that the arsenic 10 ug/L MCL. Future groundwater monitoring data will be reviewed by the Project Team as it is collected to assess whether or not changes in the compliance boundary's location, monitoring wells or land use controls/institutional controls are required.

As recommended in the Second Five-Year Review in 2002 the LTM Plan for Site 6 was modified to include the sampling and analysis of the liquid seeping from the northern slope of the former filter bed area landfill. Samples were collected in April 2003, September 2003 and again in October 2004 and were analyzed for all of the Site 6 CoCs. Since there have been no visible seeps. The results of the limited post-RA sampling and analysis of the water seeping from the side slope reflected a water quality that met the AWQC for all constituents except for iron. This iron could be the result of historic Site 6 landfilling actions but is more likely naturally occurring since the Hanscom Field/Hanscom AFB area has a significant amount of iron (as evidence by the iron filing of wells and well pumps which are components of the RA at both OU-1 and OU-3/IRP Site 21). Liquid seeping from the former filter bed area into the wetland remediation areas (WWRA & EWRA) is no longer considered to be a concern/issue since the post-RA seeps are no longer evident.

Data Review OU-3/IRP Site 21

OU-3/IRP Site 21 LNAPL/ Groundwater Collection and Treatment System Operational Data

General: At the time of the 2nd Five-Year Review in 2002 IRP Site 21 had an on-going Removal Action which was being incorporated into the selected final Remedial Action. Also at that time planning for the implementation of the 2001 ROD was underway. Subsequently, the Remedial Design and remedy construction were completed and the Site entered the long-term operation, maintenance and monitoring phase in September 2003. Review of the March 2004 *Remedial Action Report* confirms that the remedy was constructed in accordance with the ROD/Remedial Design and review of monthly Remedial Action reports since September 2003 confirms that the remedy remains in place as constructed and is operating as expected. **Figure 9** shows the layout of Site 21 to include recovery and monitoring wells, locations of the former (pre-RA) LNAPL Pools, and RI Zone designations .

This, the Third Five-Year Review, addresses the data that has been generated since the start-up of the LNAPL/Groundwater Collection and Treatment System in September 2003. Operational data for this system is reported in the monthly Remedial Action Report which is submitted to stakeholders. See **Attachment H-1** for the Hanscom AFB NPL OU-3/IRP Site 21 Remedial Action Report for December 2006. Note that the attachments to the December RA Report document most of the operational data that has been collected to date. A summary of key operational data from startup is presented in **Table 19** below. Of special note (as is the case with the OU1 system) is the durability/dependability of the system as evidenced by the time-operating percentages. Normally there are only minor/short interruptions of operations for maintenance, minor repairs or deliberate shut downs in advanced of groundwater sampling events and also during period of very heavy rain (to preclude overwhelming the oil-water separator).

Table 19 – LNAPL/ Groundwater Collection and Treatment System Operational Data

	2003	2004	2005	2006	2007
Gallons Processed	37,335	152,657	148,734	143,122	81,011
Average gpd	349	417	545	382	241
Time Operating	96.3%	96.7%	98.1%	97.1%	95.9%
Influent TPH - mg/L	0.54	0.67	0.55	0.65	0.69
Influent BTEX - ug/L	20.8	47.4	39.0	7.0	27.1
Influent TCE - ug/L	nr	7.0	12.7	25.5	34.5
Effluent TPH - mg/L	0.12	bdl	bdl	0.03	bdl
Effluent BTEX - ug/L	bdl	bdl	bdl	bdl	bdl
Effluent TCE - ug/L	bdl	bdl	bdl	bdl	bdl

Notes: TPH, BTEX & TCE data is the average of monthly samples.
bdl = below detection levels nr = not reported

Collection System: The Site 21 collection system consists of 10 recovery wells (RW-1A through RW-10A) located in the former LNAPL Pool C area of the site. During the construction phase provisions were also provided to convert passive recovery wells to active recovery wells, however, monitoring to date has not indicated that implementation of this contingency is necessary. From the September 2003 startup through March 2005 all 10 of the recovery wells were usually in operation. Since March 2005 RW-3A and RW-4A have only been operated sporadically, mainly as an optimization measure supported by the fact that the groundwater being captured was well below MCLs and that no LNAPL was being recovered. Subsequently, starting in June 2006 additional RWs have been turned off/only been operated sporadically, also for optimization. As of the end of 2006 four (4) of the ten (10) RWs were in normal around the clock operation. These are RW-1A, RW-5A, RW-6A and RW-7A. All others are in a stand-by mode/only operated sporadically. A chart of the gallons (per day) of groundwater collected and treated between 2004 and July 2007 is included as **Attachment H-2**. This chart shows periodic sharp peaks which occur during of rainfall whereas the inverse peaks (dips) reflect periods when the overall system is shutdown. Also the recurring up-down trends are primarily due to the seasonal rise and fall of the groundwater elevations which influence the individual recovery well yields but daily totals are also affected by the number of operating wells.

The collection peaks and/or high groundwater elevations are not necessarily good for (or contribute to) the effectiveness of the RA. Both conditions add to the total quantity of groundwater collected and treated but the extra is not groundwater from the lacustrine layer at the site which contains the residual LNAPL. The recovery wells were constructed to collect specifically from the lacustrine layer and the purpose of the recovery from the wells was to create a zone of depression around each well location to facilitate the flow of any residual LNAPL in the area into the well. The immediate increase in the yield of some of the 10 recovery wells (specifically RW-5A, RW-7A and RW-10A) indicate that groundwater from the area above the lacustrine layer is able to flow directly into the well, almost as if they are connected to a storm drainage system.

Except for a 1-2 week period in April 2004, there has been no evidence that any LNAPL is being recovered by the operation of the recovery wells. In April 2004 a thin lens started to develop in the oil-water separator but quickly disappeared. A specific well source for this LNAPL could not be identified but subsequent developments point the finger to RW-1A (see below). Also, it is hypothesized that the biomass (which develops in the oil-water separator) consumes any LNAPL that is captured and pumped to separator. Thus a LNAPL lens does not have a chance develop. The fact that LNAPL is not being collected by the active recovery system questions the necessity for the continued operation of the system, especially when the BTEX contaminant levels being collected (as discussed below) are insignificant. However, there are other factors which indicate that there is some benefit from continuing the active recovery component of the RA, at least in the short term.

There has been one extended system shutdown, 1 August through 1 December 2005, to determine whether or not LNAPL would re-appear in the wells. During this rebound period there

was only a trace/thin lens that developed in RW-1A with no evidence of LNAPL in any of the other 9 recovery wells.

In order to assess the contribution of each of the 10 recovery wells samples collected from either the pump's discharge or directly from the wells are periodically analyzed for VOCs and TPH by an off-site laboratory. Samples from some of the wells are also analyzed by the O&M staff using the on-site GC to detect and quantify TCE and cis-1,2-DCE. The historical summary of the results of the laboratory analysis is presented in the Table/**Attachment H-3**. These results show the quality of the groundwater being collected by the 10 recovery wells is generally below MCLs for VOCs except for the TCE (which has been found in RW-1A, and RW-3A through RW-7A) and three (3) VOC compounds (for which there is neither an MCL nor MCP GW Standard) that have a Risk-Based Remediation Goal (RBRG). These 3 compounds are 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene and n-propylbenzene and some exceedances of these compounds were found in the 2003-2005 annual analysis. However, none of the RBRGs were exceeded in the most recent analysis of October 2006 active recovery well samples. There has also been concentrations of naphthalene which have exceeded the pre-April 2006 MCP GW-1 standard of 20 ug/L (no MCL) but none have exceeded the post-April 2006 standard of 140 ug/L. Also, in the October 2005 and October 2006 annual analysis, even the original standard was met in all of 10 recovery wells. As mentioned above the BTEX contaminant levels being collected are not significant (some wells consistently below detection levels) with only meaningful (but well below MCLs/MCP GW Standards) levels found in RW-1A and RW-9A. It should also be noted that these BTEX concentrations are also trending lower since the initial 2003 S&A.

As reported above the analytical data for the 10 recovery wells identifies TCE as a contaminant of concern which had not been discovered in investigations prior to the activation of the recovery system. This TCE appears to be localized in the vicinity of RW-6A and RW-7A. However, during the 2005 S&A event which occurred after more that a 2-month system shutdown, an increased in TCE was found in RW-3A and RW-4A. The RWs with detections of TCE are all in a line and parallel to an underground sanitary sewer line. It is hypothesized that the bedding material for the sewer line serves as a conduit, facilitating the migration of the TCE from the vicinity of RW-6A towards the west (RW-1A through 5A). This hypothesis appears to have been validated by the 2006 S&A which found that the TCE concentrations in RW-3A and RW-4A had declined back to below MCLs whereas the TCE increased in RW-6A and RW-7A. For 2006 the shutdown period to allow the groundwater conditions to recover from the system operation was less than 1-week. As noted in the OU1 section of this document the O&M staff has been able to use an on-site GC to provide screening/trend analysis specifically for TCE and cis-1,2-DCE. Through trial and error it has been determined that the on-site GC can also provide screening/ trend analysis for TCE and cis-1,2-DCE in Site 21 RW samples which contain little to no other VOC compounds, which is situation for RW-2A through 7A. Therefore the annual RW S&A has been augmented by the on-site GC analysis of samples collected on a more frequent basis (target of monthly for RW-6A and RW-7A). The historical summary of the results of this on-site GC analysis of Site 21's RWs is presented in the Table with chart included in the monthly RA Reports (see **Attachment H-1** for analysis through December 2006).

During this review period there was also a one-time/baseline analysis of the RWs for total petroleum hydrocarbons (TPH). TPH is a treatment system discharge limit parameter (5 mg/L) and the purpose of the RW TPH analysis was to identify which wells were contributing significant TPH to the composite treatment system influent. This analysis found only two wells with TPH in excess of 1.0 mg/L (RW-1A at 7.03 and RW-9A at 1,87). There is also a MCP Method 1 GW-1 Standard of 0.2 mg/L for TPH (GW-2 = 1.0 ug/L), however, the TPH standards are qualified in that it is a valid option only for C9 and greater petroleum hydrocarbons and not appropriate for the characterization of risks associated with lighter (gasoline-range) hydrocarbons. Levels exceeding the 0.2 mg/L GW-1 Standard were found in 8 of the 10 wells whereas only RW-1A and RW-9A had levels which exceeded the 1.0 mg/L GW-2 Standard.

In summary the amount of LNAPL being recovered (nil) and the levels of BTEX in the groundwater within the former LNAPL Pool C area (very low) do not warrant continuation of the RA's active recovery well component. However, there are is some benefit from continuing the operation of RW-6A and RW-7A to cleanup the localized TCE hotspot. Also since RW-1A has the highest BTEX and TPH levels and a LNAPL trace/thin lens develops when it is shutdown for a period there is some benefit to continue its operation (at least while the TCE persists at RW-6A and RW-7A). As stated above only four (4) of the ten (10) RWs were in normal around the clock operation at the start of 2007. RW-5A has been included with RW-1A, RW-6A and RW-7A to help contain the TCE hotspot and preclude the migration to the west seen during the extended 2005 shutdown. The remaining wells will be monitored for any rebound in LNAPL and or groundwater contaminants that warrants re-activation of their pumps.

Treatment System: Following a variable startup frequency samples of the treatment system's influent and effluent have been analyzed by an off-site laboratory for TPH and VOCs on a monthly basis. The table included in the December 2006 RA Report (**Attachment H-1**) summarizes all analysis since the September 15, 2003 startup through the end of 2006. This shows that even the influent's TPH levels is always well below the NPDES discharge limit (5 mg/L) and that the effluent's TPH is usually below the laboratory's detection level. The influent data also shows that TCE is the only VOC being recovered and treated which exceeds its NPDES discharge limit (5 ug/L) MCL and that the effluent has always been below the laboratory's detection level for TCE. Thus it can be concluded that the Site 21 groundwater treatment system is effective.

Charts included in the December 2006 RA Report (**Attachment H-1**) graphically show the TPH and TCE levels found in the influent since startup. The chart for TPH shows fluctuating levels prior to the extended system shutdown in 2005 and does appear to reflect a downtrend since the December 2005 re-start. While the chart for TCE shows a definite up trend from startup through the end of 2006, this chart also show the impact of the optimization measures which commence in June 2006 (shutdown some of the RWs discussed above); i.e., a greater percentage of the composite influents now comes from RW-6A and RW-7A.

OU-3/IRP Site 21 LNAPL Monitoring/Passive LNAPL Collection

A component of the Site 21 Remedial Action is a monitoring program to track levels of residual LNAPL floating on the surface aquifer groundwater. This monitoring was initiated following the 2003 RA construction activities (removal of petroleum contaminated soil, construction of interceptor trenches, and installation of active and passive recovery wells) at the site. Initially all wells with a historical LNAPL presence and those within the perimeter of the former LNAPL Pools (A, B & C) where monitored monthly. Subsequently, after the November 2004 LNAPL monitoring event, the frequency for those wells with more than one year of no LNAPL detections was changed to semi-annually. Also any site well sampled as part of the long-term monitoring (LTM) program is also checked for the presence of LNAPL. The results of the LNAPL monitoring are reported in the monthly Remedial Action Report and also in the LTM Reports. LNAPL monitoring to date has found that LNAPL has not returned to the areas of former LNAPL Pools A and B and has also not returned to the interceptor trenches in the area of former LNAPL C. However, traces to minor thicknesses of LNAPL continue to be periodically found in existing monitoring wells outside the limits of the Pool C trenches but within the perimeter of former LNAPL Pool C. These existing monitoring wells are ECS-29, ECS-35, MWZ-13, MWZ-15, MWZ-20 and MWZ-22. The table included in the December 2006 RA Report (**Attachment H-1**) summarizes the LNAPL monitoring of the wells which have had a post-RA detection of LNAPL. The post-RA LNAPL monitoring indicate that the 2003 RA's removal and disposal of petroleum contaminated soil effectively removed most of the residual LNAPL, especially in the former LNAPL Pool A and Pool B areas of the site.

As noted above traces to minor thicknesses of LNAPL continue to be periodically found in existing monitoring wells ECS-29, ECS-35, MWZ-13, MWZ-15, MWZ-20 and MWZ-22 and January 2004 the use of a Petrobailer (passive LNAPL collectors) in the monitoring wells with a measurable LNAPL lens thickness was initiated. These were successful in capturing some LNAPL and reducing the "rebound" thickness of lens whenever the devices were removed. Over time the effectiveness of the petrobailers and they were replaced by absorbent socks. Charts included in the December 2006 RA Report (**Attachment H-1**) graphically show the fluctuating LNAPL and groundwater elevations the thickness of the LNAPL lens in MWZ-13 and MWZ-22 since September 2003. Two observations can be drawn from these charts and/or **Attachment H-1**; 1) LNAPL lens thickness appears to be greater at lower elevations and 2) the thickness of the lens has decrease over time. While on the surface the passive LNAPL recovery effort has been successful it should also be noted that the total quantity of LNAPL recovered from the petrobailers or squeezed from the absorbent socks still has not filled a 1-gallon container.

OU-3/IRP Site 21 LTM Data

As discussed above in earlier sections of this report the long-term monitoring of OU-3/IRP Site 21 in 1992 and an extensive network of monitoring and recovery wells has been established to monitor LNAPL and to assess the site's groundwater. This network of monitoring points at IRP

Site 21 is shown in **Figure 9**. The Basewide Quality Assurance Project Plan for Long Term Monitoring at Operable Unit 1 and Operable Unit 3 (Site 6 and 21) reflects 2 stages for the Site 21 LTM Plan, Stage 1 was the pre-RA stage and the on-going Stage 2 is the post-RA stage which commenced with a "baseline" event on October 2003. The results of this baseline event are presented in the *October 2003 Stage 2 Post-RA Baseline Long-Term Monitoring Report for Operable Unit 3 – IRP Site21,* dated March 2002, which was prepared by Shaw Environmental, Inc. Subsequently samples are collected from selected monitoring points on a semi-annual or annual basis and analyzed for VOCs or SVOCs to monitor progress towards achievement of the RAOs. These semi-annual/annual monitoring events are documented in LTM Reports with the most recent being the April and October 2006 *Long-Term Monitoring Report for Operable Unit 3 – IRP Site21,* dated March 2002, which was prepared by Shaw Environmental, Inc. A Table is included in each LTM Report which summarizes all LTM exceedances of a standard (surface water and groundwater/MCLs, MCP GW-1 & 2 and RBRGs). **Table 4-1** from the 2006 LTM Report is at **Attachment H-5.** This table provides a summary of the post-RA LTM and Charts showing LTM trends for contaminants of concern for selected wells are at **Attachment H-6.**

Of primary concern in the post-RA stage is confirmation of that water quality of the adjacent Shawsheen River is not being threatened by the LNAPL and/or groundwater contamination at Site 21. **Table 20** below summarizes the results of the post-RA sampling of the Shawsheen River at the stream gauging station immediately downgradient of the site. While there have been sporadic detections of the Site 21 VOC CoCs these detections have always been well below drinking water standards. Based on the low levels being detected it is concluded that neither the LNAPL nor the dissolved-phase plume is adversely impacting the water quality of the Shawsheen River. Also note that the contaminants detected in the river could actually be from the surface water runoff from the paved areas of Hanscom AFB and Hanscom Field which make up the majority of the flow in the river at this monitoring point.

Table 20: OU-3/IRP Site 21- Shawsheen River Surface Water Monitoring Point (Gauging Station)

Groundwater Plume Contaminants of Concern	EPA MCL	MCP GW-1	MCP GW-2	Oct-03 RA-C BL	Apr-04 RA-O LTM	Nov-04 RA-O LTM	Apr-05 RA-O LTM	Oct-05 RA-O LTM	Apr-06 RA-O LTM	Oct-06 RA-O LTM	Apr-07 RA-O LTM
Total BTEX				ND	0.31 F	ND	0.2 F	ND	ND	ND	ND
1,2-Dichlorobenzene *	600	600	2,000	<0.04	0.022 F	0.34 F	<0.067	<0.15	0.12 F	<0.019	0.100 F
1,4-Dichlorobenzene *	75	5	200	<0.025	0.13 F	0.14 F	<0.039	<0.23	<0.017	<0.017	<0.017
Methyl-tert-butyl-ether	none	70	50,000	na	2.11 F	2.28 F	0.7 F	0.62 F	0.58 F	0.760 F	0.950 F
Trichloroethene *	5	5	30	0.3F	0.34 F	0.44 F	0.25 F	0.30 F	0.50 F	0.290 F	0.240 F
cis-1,2-Dichloroethene *	70	70	100	0.7F	0.77 F	0.88 F	0.67 F	0.78 F	0.86 F	0.900 F	0.800 F

Notes: All quantities = ug/L (parts per billion) < = analytical results were below indicated level ND = analytical results were below detection levels
ND = analytical results were below detection levels F = analytical results were above detection levels but below reporting levels
Compound name with * following indicates that the compound's MCP Method 1 Standards were revised April 3, 2006

Also of primary concern in the post-RA LTM stage is confirmation of there is a natural containment of the LNAPL and natural containment/apparent natural attenuation of the dissolved-phase plume. In this regards five monitoring wells located downgradient from the dissolved phase plumes in the north and northwest section of the site (Zone 5) are considered sentry wells. These sentry wells are ESC-38, ECS-39, ECS-40, ECS-41 and ECS-42. Two of these wells (ECS-38 and ECS-39) had pre-RA exceedances of some standards, whereas the other three have consistently been near or below the laboratory detection levels for all VOCs. At ECS-39 there had been three pre-RA CoCs; 1,4-dichlorobenzene, TCE and vinyl chloride. However, post-RA results for ECS-39 have consistently met all standards with only low to below the laboratory detection levels for all VOCs. With this documented post-RA cleanup of the groundwater in ECS-39 the only sentry monitoring well to have any post-RA exceedance of a standard (1,4-dichlorobenzene) is ECS-38). Please note that 1,4-dichlorobenzene is the only historical and/or current CoC in the groundwater sampled from ECS-38. The post-RA 1,4-dichlorobenzene concentrations in ECS-38 are shown on the graph/**Attachment H-6a** and they do appear to be slowing decreasing. However, the 11 ug/L in the May 2007 LTM event is still above the MCP GW-1 standard of 5 ug/L. Also of note is that since the well was initially sampled in 1995, with the exception of the Site 21 RI monitoring in 1997, the 1,4-dichlorobenzene concentrations have been less than USEPA's MCL of 75 ug/L.

As discussed in earlier sections of the report Site 21 is primarily a petroleum contaminated site, however, pre-RA investigations identified a hotspot in the vicinity of monitoring well ESC-28 located in the northeast section of the site (Zone 3) which contained tetrachloroethene (PCE) and/or its daughter products (TCE/cis-1,2-DCE/VC). As inferred, bio-degradation of the PCE et al has, and continues to occur to the point that the post-RA baseline monitoring found that only vinyl chloride was at a concentration above a standard. The post-RA concentrations of vinyl chloride in ECS-28, as shown on the graph/**Attachment H-6b,** do appear to be slowing decreasing and, in the May 2007 semi-annual LTM event, dropped below the MCL/MCP GW-1 standard of 5 ug/L for the first time. Additional monitoring is required to confirm that the cleanup of the groundwater in this monitoring well is complete.

The LTM of ECS-28 also identified what appears to be evidence of relatively recent release of gasoline containing MTBE, most probably associated with the current land-use as a recreation vehicle long-term storage facility. The laboratory analysis of ECS-28 samples starting in November 2004 included MTBE in its Method 8260 list of compounds and at this time reported an MTBE concentration of 334 ug/L (which exceeded the MCP GW-1 standard of 70 ug/L). The MBTE concentration declined in each subsequent semi-annual monitoring event to below the standard as show in **Table 21** on the next page. Benzene also spiked above its MCL (5 ug/L) to 21 ug/L in April 2006 but returned to less than the MCL in the October 2006 (1.85 ug/L) and May 2007 (2.36 ug/L) LTM events. As stated above additional monitoring is required to confirm that the cleanup of the groundwater in this monitoring well is complete.

Table 21 - ECS-28-Methyl-tert-butyl-ether (MCP GW-1 standard = 70 ug/l (no MCL))					
Nov-04	Apr-05	Oct-05	Apr-06	Oct-06	May-07
334	260	130	43	48	5

On-site dissolved-phase groundwater contaminants which exceeds a standard, in addition to those discussed above, are listed in the **Attachment H-5** and include benzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, TCE, and four (4) VOC compounds (for which there is neither an MCL nor MCP GW Standard) that have a Risk-Based Remediation Goal (RBRG). These 4 compounds are 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, n-propylbenzene and sec-butylbenzene.

Exceedances of benzene, 1,2-dichlorobenzene and 1,4-dichlorobenzene are found in the southeastern section (Zone 2 and former railroad track area) with the most significant contamination in ECS-31 (concentrations of 1,2-dichlorobenzene and 1,4-dichlorobenzene in October 2006 of 872 ug/L and 276 ug/L respectively). Benzene in this section of Site 21 has been in a downtrend and in October 2006 the 5.11 ug/L concentration in RW-1 was slightly above the MCL/GW-1 standard.

Exceedances of TCE, as noted in the earlier discussion concerning the "Collection System", has been found in the area of former LNAPL Pool C, specifically in the line of active recovery wells (RW-1A through RW-7A) which parallel the sanitary sewer line. A TCE MCL exceedance (19 ug/L) was also found in monitoring well ECS-35 (which is just east of RW-7A) in the October 2006 LTM event. The presence of TCE in this section of Site 21 will continue to be addressed by the operation of RW-6A and RW-7A as long as necessary to eliminate the pocket of TCE.

Exceedances of one or more of the 4 compounds with RBRGs are generally associated with the following sections of Site 21:

- In the vicinity of former LNAPL Pool C to include monitoring wells with post-RA detections of LNAPL (ECS-35, MWZ-13, MWZ-15, MWZ-20 and MWZ-22) and some of the active recovery wells (RW-1A, RW-2A and RW-9A)
- The interceptor trench in the area of the former LNAPL Pool A and its downgradient area (PW-3, PW-4, PW-5, MWS-108 and MWZ-3), and
- The area of a heating fuel release in 1990 in Zone 3 (MWZ-12 and MWZ-11).

The active recovery wells within former LNAPL Pool C have included in the annual LTM event, however, monitoring wells in the vicinity have not been routinely sampled and analyzed due to the presence of LNAPL. **Table 22** on the following page summarizes the 1,2,4-trimethylbenzene concentrations found in the former LNAPL Pool C area. The 1,2,4-trimethylbenzene data is representative of other 3CoCs with a RBRG data collected to date in this area of Site 21 and shows that there is insufficient data to determine whether or not there is a trend in the

concentrations of the 4 CoCs with a RBRG. However, as noted in the earlier discussion concerning "LNAPL Monitoring/Passive LNAPL Collection", passive LNAPL recovery measures have been successful in reducing the residual LNAPL levels to the point that groundwater quality data should be able to be routinely obtained in future LTM events.

Table 22 – LNAPL Pool C - 1,2,4-Trimethylbenzene (RBRG = 21 ug/L)				
Monitoring Well	13-Oct-03	4-Nov-04	19-Oct-05	10-Oct-06
ECS-29	LNAPL	LNAPL	LNAPL	35
ECS-35	0.25 F	LNAPL	LNAPL	<0.012
MWZ-13	LNAPL	LNAPL	LNAPL	295
MWZ-15	LNAPL	LNAPL	LNAPL	60/58
MWZ-17	37	ns	ns	na
MWZ-20	LNAPL	LNAPL	LNAPL	56/64
MWZ-22	LNAPL	LNAPL	LNAPL	63
Recovery Well	1-Dec-03	4-Nov-04	20-Oct-05	10-Oct-06
RW-1A	219	77	48	12
RW-2A	76	3	nr	0.11 F
RW-4A	1	<0.016	nr	<0.012
RW-6A	<1	<0.016	0.21 F	<0.024
RW-9A	24	16	31	17
RW-10A	<1	66	0.72 F	<0.060

The monitoring wells within the interceptor trench in the area of the former LNAPL Pool A and its downgradient area have been included in the LTM Plan since the RA construction activities were completed in 2003 and the graph/**Attachment H-6c** is representative of LTM groundwater quality data collected to date in regards to the 4 compounds with RBRGs in this section of Site 21. This chart shows a down trend in PW-5 & MWS-108, relatively flat trend in PW-3 and an up trend in PW-4 & MWZ-3. Benzene in addition to the 4 compounds with RBRGs remains a CoC in this section of the site with an slight exceedance of the 5 ug/L MCL/GW-1 standard noted in October 2006 in PW-4 (7.25 ug/L). The benzene concentration in this well did drop to 4.0 ug/L in May 2007 event and, if confirmed by future LTM results, benzene will no longer be a CoC for the former LNAPL Pool A section of the site. Also, a future application of ORC® in the interceptor trench to accelerate the natural attenuation of the 4 compounds with RBRGs in this area is under consideration.

The LTM data for the CoCs with a RBRG in monitoring well MWZ-12 in area of a heating fuel release in 1990 in Zone 3 is shown on the graph/**Attachment H-6d.** That fact that there were 4 CoCs with a RBRG was overlooked in the initial post-RA LTM events and the evaluation of LTM data initially did not identify any of these 4 compounds as a CoC for Site 21. This omission was subsequently rectified but, since there are only 3 LTM results to date for MWZ-12, it is difficult to determine whether or not a definitive trend is in-place. Also note that in October 2006 the only RBRG exceedance in the sample from MWZ-11 (which is downgradient of MWZ-

12) was 5.11 ug/L of n-Propylbenzene (RBRG = 4 ug/L). However, the concentrations of this CoC have been slowly increasing (1.8 ug/L in 2003 & 2.7 ug/L in 2005). As with MWZ-12 and additional monitoring of MWZ-11 is required to determine whether or not these CoCs are significant enough to warrant additional remedial measures to ensure that the RAOs are achieved.

Summary: The Review of the operation, maintenance and monitoring data for OU-3/IRP Site 21 shows that the remedy is successfully achieving the RAOs and that continued progress will return groundwaters to federal drinking water standards (i.e., MCLs and non-zero MCL goals (MCLGs)), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards) within an acceptable time period (< 100 years).

Site Inspection

An inspection of the Site was conducted on July 24, 2007, by the Hanscom AFB Installation Restoration Program Manager accompanied by the USEPA and MA DEP Remedial Project Managers for the Hanscom Field/Hanscom AFB NPL Site. The purpose of this inspection was to confirm current land use and to assess the protectiveness of the remedies for OU-1/IRP Sites 1, 2 and 3, OU2/IRP Site 4, OU3/IRP Site 6, and OU3/IRP Site 21. No significant issues were identified and no activities were observed that would indicate that areas with subsurface soil contamination had been excavated or that the groundwater was being used for potable/non-potable purposes.

OU-1/IRP Sites 1, 2 and 3: All 3 sites are within the restricted/fenced perimeter of Hanscom Field which is patrolled by Massport operational and security personnel. IRP Site 1 with the VER system is also fenced to segregate the area from the active airfield and adjacent US Navy property. At IRP Sites 2 and 3 recharge basins are constructed over the drum burial pits which precludes access to any residual subsurface soil contamination. The central treatment facility is fenced with access to it controlled by the Hanscom AFB's remedial action contractor's on-site staff. The storm drainage ditch where the effluent from the treatment system is discharged was checked and no evidence of an adverse impact of the discharge was observed.

OU-2/IRP Site 4: This site is part of Hanscom Field in the Runway 5 Approach but is outside the perimeter fencing of the active part of the airfield. Vehicle access to this area is restricted by locked gates and physical barriers, however, the area is accessible on foot. The capped areas, berms, side slopes, drainage structures were observed in good condition and as constructed in 1988. The maintenance recommendations of the 1st Five-Year Review were found to be fully implemented.

OU-3/IRP Site 6: This site is on Hanscom AFB and access to the base is restricted to authorized personnel. The site is also separately fenced with signs advising that it is an IRP site and that digging and dumping are not authorized. The Site is being utilized by active Air Force personnel for readiness training, however, all activities are in keeping with the open space land use. The capped areas, side slopes/toe drains and drainage structures were observed in excellent condition and as constructed in 2001. Also the remediated wetland areas appeared to be healthy and fully restored. The seeping of discolored liquid from the north side of the former filter bed area into the wetland restoration areas (which was noted in the Remedial Action Report for Landfill Capping Project at Operable Unit 3 – Site 6) was not observed.

OU-3/IRP Site 21: As with IRP Site 6 this site is on Hanscom AFB and access to the base is restricted to authorized personnel. The active LNAPL/groundwater recovery and treatment system was in operation and "industrial" land use of the Site 21 area was observed to be un-changed.

Interviews

Interviews were conducted with various parties connected to the site. During the July 24, 2007 inspection, The USEPA and MA DEP RPMs were interviewed. Neither identified any concerns regarding the Hanscom Field/Hanscom AFB NPL Site. Mr. Rich Landry, the Hanscom AFB Remedial Action-Operations contractor's field/on-site manager and his assistant, Mr. Daniel Kelly, were interviewed on July 29, 2007. Neither identified any issues/concerns with the operation, maintenance and monitoring associated with the on-going remedial actions.

VII. Technical Assessment

OU-1/IRP Sites 1, 2 and 3

Question A: *Is the remedy functioning as intended by the decision documents?*

Remedial Action Performance: The review of documents, ARARs, risk assumptions, and the results of the site inspection indicates that the remedy is functioning as intended by the IROD/pending ROD. Surface water and groundwater sampling as part of the LTM Plan confirms that operation of the remediation system has achieved the remedial objectives to minimize the migration of groundwater contaminants and to reduce the contaminant concentrations of groundwater discharges to surface water to below groundwater standards. This monitoring also confirms that the IROD's secondary objective to decrease contaminants near the source area and to reduce the size of the off-site dissolved phase plume, i.e., draw back the plume toward the source areas is being met. Also, the pending ROD's secondary objectives (ensue that excavation at the three source areas (IRP Sites 1, 2 and 3) is controlled to prevent exposure to any residual contamination in the subsurface soil and to prevent exposure to vapors that could accumulate in buildings affected by the contaminated groundwater plume) are being met by the monitoring and enforcements of LUCs/ICs. In August 2001 groundwater recovery, treatment and recharge was suspended at IRP Site 3 and monitoring since then indicates that active remediation of the IRP Site 3 source area may no longer be necessary. This suspension continues to be considered an interim action. In the future groundwater collection and recharging will be reinitiated to conduct an additional rebound test to confirm that no further active cleanup is required for IRP Site 3.

System Operations/O&M: Operation and maintenance of the groundwater collection, treatment and recharge system has, on the whole, been extremely effective. The system operates continuously around-the-clock with periodic scheduled/unscheduled shutdowns for maintenance or repairs. The system has consistently operated for greater than 97.5% of possible hours. As a result of capital improvements in 1996 current O&M annual costs are now significantly less than original estimates and there are no indications of any difficulties with the remedy.

Opportunities for Optimization: Starting in 1996 there have been several changes in the system with the objective of optimization and, as indicated above, in keeping with the IROD's/pending ROD's primary objective of "... continued operation of the existing dynamic groundwater treatment system ..." additional opportunities have been and will continue to be investigated. Optimization actions since the 2002 review are listed in Section V.

Early Indicators of Potential Issues: There have been no frequent equipment breakdowns or changes in operation, maintenance and monitoring data that indicate a potential/developing issue. There are no known issues or problems associated with the OU-1 Remedial Action that could place protectiveness at risk.

Implementation of Land Use Controls/Institutional Controls and Other Measures: With the exception of establishing MOAs with Massport and Bedford the LUCs/IC's including in the IROD have been fully implemented, monitored and enforced. Also, the LUCs/ICs listing in the pending ROD are already implemented. Both Massport and Town of Bedford officials declined to formalize any further the existing LUCs/ICs for Hanscom Field and Town of Bedford Forest/conservation land. However, Massport did incorporate additional/updated information on the Hanscom AFB IRP in their 2005 L.G. Hanscom Field Environmental Status and Planning Report (ESPR).

Question B: *Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?*
Changes in Standards and To Be Considered: The ARARs listed in the pending OU-1 ROD that must be met and that have been evaluated are included in Attachment B-1. These include federal drinking water standards (i.e., MCLs and non-zero MCLGs), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards); ARARs related to the site's location (surface water and wetlands); and ARARs related to groundwater and treatment systems' monitoring. There have been no changes in these ARARs and no new standards or TBCs identified that affect the protectiveness of the OU-1 remedy.

Changes in Exposure Pathways, Toxicity, and Other Contaminant Characteristics: Physical site conditions or the understanding of these conditions have not changed in a way that could affect the protectiveness of the remedy. The land use on or near the site remains un-changed and there are no newly identified contaminants or contaminant sources. Human health or ecological routes of exposure or receptors have not been newly identified or changed in a way that could affect the protectiveness of the remedy. There are no unanticipated toxic byproducts of the remedy not previously addressed by the decision documents.

Changes in Risk Assessment Methods: Standardized risk assessment methodologies have not changed in a way that could affect the protectiveness of the remedy.

Expected Progress Towards Meeting RAOs: The remedy is progressing as expected.

Question C: *Has any other information come to light that could call into question the protectiveness of the remedy?*

No newly identified human health or ecological risks been found and no weather-related events have affected the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

Technical Assessment Summary: According to the data reviewed, site inspections, and interviews, the remedy is functioning as intended by the IROD/pending ROD and there have

been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no changes in the toxicity factors for the contaminants of concern that were used in the baseline risk assessment and there have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

OU-2/IRP Site 4

Question A: *Is the remedy functioning as intended by the decision documents?*

Remedial Action Performance: The review of documents, ARARs, risk assumptions, and the results of the site inspection indicates that the remedy is functioning as intended by the 1988 Remedial Action Plan. Since the 2nd Five-Year Review, the physical site conditions or the understanding of these conditions have not changed in a way that could affect the protectiveness of the remedy. The protectiveness the landfill cap had previously been confirmed by the long-term monitoring conducted between December 1989 and September 1992, Supplemental Sampling and Analysis conducted in 1995 and 1996, the Human Health and Ecological Risk Assessments completed in 1997, and the 1st Five-Year Review conducted in 1997. The 1st Five-Year Review concluded "based on the field inspection, and human health and ecological risk assessment, protectiveness of the landfill cap at Site 4 has been demonstrated". The assessment of this five-year review found that the recommendations of the 1st Five-Year Review continue to be implemented and that a long-term inspection and maintenance program is in place to ensure continued protectiveness of the remedy. Quarterly inspections confirm that there have been no changes of any kind since the 2nd Five-Year Review that could affect the protectiveness of the remedy.

Question B: *Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?*

The Human Health Risk Assessment concluded that "there are no unacceptable risks associated with exposure to Site 4 media" and the Ecological Risk Assessment concluded that "there are no significant ecological risks associated with Site 4." There have been no changes to standardized risk assessment methodologies, exposure assumptions, or toxicity data which would affect these risk assessments.

Question C: *Has any other information come to light that could call into question the protectiveness of the remedy?*

No newly identified human health or ecological risks been found and no weather-related events have affected the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

Technical Assessment Summary: According to the data reviewed, site inspections, and interviews, the remedy is functioning as intended by the 1988 Remedial Action Plan and there have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no changes in the toxicity factors for the contaminants of concern that were used in the baseline risk assessments and there have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

OU-3/IRP Site 6

Question A: Is *the remedy functioning as intended by the decision documents?*

Remedial Action Performance: The review of documents, ARARs, risk assumptions, and the results of the site inspection indicates that the remedy is to be functioning as intended by the ROD. The capping of contaminated soils and removal of contaminated wetland soil has achieved the remedial objectives to prevent direct contact with contaminants in surface soils, to reduce exposure of ecological receptors to contamination, and to minimize erosion of contaminants from the site to the adjacent wetlands and pond. A formal inspection and maintenance program is in place to ensure that the physical site conditions or the understanding of these conditions have not changed in a way that could affect the protectiveness of the remedy. Quarterly inspections confirm that there have been no changes of any kind since the 2nd Five-Year Review that could affect the protectiveness of the remedy. LTM data confirms that the Site 6 CoCs are not leaving the site via the surface water flowing from the wetlands and surface water and groundwater sampling as part of the LTM Plan confirms that, with the exception of the dissolved arsenic, natural flushing and natural attenuation are slowing reducing the size and strength of the on-site contaminants.

Implementation of Land Use Controls/Institutional Controls and Other Measures: The LUCs/IC's including in the ROD have been fully implemented, monitored and enforced. Also, Massport incorporated additional/updated information on the Hanscom AFB IRP (includes Site 6)in their 2005 L.G. Hanscom Field Environmental Status and Planning Report (ESPR).

Question B: Are *the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?*

Changes in Standards and To Be Considered: The ARARs listed in the ROD that must be met and that have been evaluated are included in Attachment B-3. The These include federal drinking water standards (i.e., MCLs and non-zero MCLGs), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards) and ARARs related to the site's location (surface water and wetlands). There have been no changes in these ARARs and no new standards or TBCs identified that affect the protectiveness of the OU-3/IRP Site 6 remedy. However, the Safe Drinking Water Act (SDWA)

was changed in 2001 to lower the arsenic standard from 50 ug/L to 10 ug/L. Since, as discussed earlier in this report, arsenic is the principal contaminant of concern in the on-site groundwater and this change may necessitate further adjustment of the groundwater compliance boundary or implementation of the contingency groundwater remedy in the event LTM monitoring results show that the remedy is not effective in maintaining groundwater quality outside the compliance boundary. Data, collected in accordance with the LTM Plan for IRP Site 6, will be analyzed by the Project Team as collected to assess whether or not changes are required prior to the completion of the next (4th) Five-Year Review in 2012.

Changes in Exposure Pathways, Toxicity, and Other Contaminant Characteristics: Physical site conditions or the understanding of these conditions have not changed in a way that could affect the protectiveness of the remedy. The land use on or near the site remains un-changed and there are no newly identified contaminants or contaminant sources. Human health or ecological routes of exposure or receptors have not been newly identified or changed in a way that could affect the protectiveness of the remedy. There are no unanticipated toxic byproducts of the remedy not previously addressed by the decision documents.

Changes in Risk Assessment Methods: Standardized risk assessment methodologies have not changed in a way that could affect the protectiveness of the remedy.

Expected Progress Towards Meeting RAOs: The remedy is progressing as expected.

Question C: *Has any other information come to light that could call into question the protectiveness of the remedy?*

No newly identified human health or ecological risks been found and no weather-related events have affected the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

Technical Assessment Summary: According to the data reviewed, site inspections, and interviews, the remedy is functioning as intended by the ROD for OU-3/IRP Site 6, however, additional data/time is required to confirm that the revised Groundwater Compliance Boundary adequately defines where the dissolved arsenic plume ends. Data, collected in accordance with the LTM Plan for IRP Site 6, will be analyzed by the Project Team as collected to assess whether or not changes in the boundary's location, monitoring wells or LUCs/ICs are required. It is noted that there have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. Also there have been no changes in the toxicity factors for the contaminants of concern that were used in the baseline risk assessments, and there have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

OU-3/IRP Site 21

Question A: *Is the remedy functioning as intended by the decision documents?*

Remedial Action Performance: The review of documents, ARARs, risk assumptions, and the results of the site inspection indicates that the remedy is functioning as intended by the ROD. Surface water and groundwater sampling and analysis as part of the LTM Plan confirms that construction of the interceptor trenches and operation of the LNAPL/groundwater recovery (and treatment) system has achieved the remedial objectives to prevent or minimize further migration of the contaminant plume (dissolved-phase CoCs) and of contaminants from source materials (VOCs/LNAPL) to groundwater. This monitoring confirms that groundwater containing CoC concentrations that exceed standards is not discharging into the Shawsheen River and that the RAO to return groundwaters to federal and state drinking water standards and state groundwater risk characterization standards should be met within an acceptable time period (< 100 years).

The RAO to prevent exposure (via ingestion, inhalation and/or dermal contact) to groundwater containing CoC concentrations that exceed federal drinking water standards (i.e., MCLs and non-zero MCLGs), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards) are being met by the monitoring and enforcement of LUCs/ICs.

System Operations/O&M: Operation and maintenance of the LNAPL/groundwater recovery and treatment system has, on the whole, been effective. The fact that there has been no measurable amount of LNAPL recovered is considered to be due the fact that little to no residual LNAPL remained on-site after the construction of the interceptor trenches (which removed a significant amount of petroleum contaminated from the site) in 2003. The system operates continuously around-the-clock with periodic scheduled/unscheduled shutdowns for maintenance or repairs. The system has consistently operated for greater than 96.9% of possible hours.

Opportunities for Optimization: Pulse operation of some of the 10 active recovery wells commenced in 2006 when monitoring data indicated that no LNAPL was being recovered and that VOCs concentrations in the groundwater being recovered were low to below detection levels. This pulse operation will continue, as suggested by monitoring data, in the future,
Early Indicators of Potential Issues: There have been no frequent equipment breakdowns or changes in operation, maintenance and monitoring data that indicate a potential/developing issue. There are no known issues or problems associated with the OU-3/IRP Site 21 Remedial Action that could place protectiveness at risk.

Implementation of Land Use Controls/Institutional Controls and Other Measures: The LUCs/IC's including in the ROD have been fully implemented, monitored and enforced.

Question B: *Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?*

Changes in Standards and To Be Considered: The ARARs listed in the ROD that must be met and that have been evaluated are included in Attachment B-3. These include federal drinking water standards (i.e., MCLs and non-zero MCLGs), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards); ARARs related to the site's location (Shawsheen River); and ARARs related to groundwater and treatment system monitoring. There have been no changes in these ARARs or TBCs identified that affect the protectiveness of the OU-3/IRP Site 21 remedy. However, in April 2006 the MCP Method 1 standards were revised for all classes (GW-1/2/3) which did impact potential contaminants of concern. Most notably the increase of the GW-1 standard for naphthalene from 20 ug/L to 140 ug/L removed this compound from the list of contaminants of concern in the groundwater at Site 21.

Changes in Exposure Pathways, Toxicity, and Other Contaminant Characteristics: Physical site conditions or the understanding of these conditions have not changed in a way that could affect the protectiveness of the remedy. The land use on or near the site remains un-changed and there are no newly identified contaminants or contaminant sources. Human health or ecological routes of exposure or receptors have not been newly identified or changed in a way that could affect the protectiveness of the remedy. There are no unanticipated toxic byproducts of the remedy not previously addressed by the decision documents.

Changes in Risk Assessment Methods: Standardized risk assessment methodologies have not changed in a way that could affect the protectiveness of the remedy.

Expected Progress Towards Meeting RAOs: The remedy is progressing as expected.

Question C: *Has any other information come to light that could call into question the protectiveness of the remedy?*

No newly identified human health or ecological risks been found and no weather-related events have affected the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

Technical Assessment Summary: According to the data reviewed, site inspections, and interviews, the remedy is functioning as intended by the ROD and there have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There have been no changes in the toxicity factors for the contaminants of concern that were used in the baseline risk assessment and there have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

VIII. Issues Identified During the Technical Assessment

There are no issues related to current site operations, conditions, or activities that affect current and/or future protectiveness of any of the Hanscom Field/Hanscom AFB remedies.

IX. Recommendations and Follow-up Actions

The following are required and suggested improvements to current site operations, activities, remedies, or conditions. Hanscom AFB is responsible for their implementation with regulatory oversight by USEPA Region I and/or MA DEP.

OU-1/IRP Sites 1, 2 and 3

- Continue to implement Remedial Process Optimization initiatives as suggested by operational experience, monitoring and the evolution of new applicable remediation technologies to complete the cleanup in the most cost effective and timely manner possible, and

OU-2/IRP Site 4 - none

OU-3/IRP Site 6

- Determine whether or not dissolved thallium is a contaminant of concern in the on-site groundwater,
- Determine whether or not the groundwater compliance boundary is adequately defined by the current network of monitoring wells.

OU-3/IRP Site 21- none

X. Protectiveness Statement(s)

OU-1/IRP Sites 1, 2 & 3

- The remedy at OU-1 is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

Current data indicates that residual contaminant sources are being removed/destroyed, that the dissolved-phase plume is contained, and that groundwater containing CoC concentrations exceeding ARARs is not discharging into the surface water/wetlands of OU-1. Continued operation of the dynamic groundwater remediation system will, over time, permanently eliminate the plumes of contaminated groundwater and the source of groundwater contamination. Also, based on the CDW model, there is now a reasonably estimated 30-50 year time frame to complete the cleanup. LUCs/ICs (whilst the remedy operates to meet the cleanup goals) prevent exposure to and use of contaminated groundwater; ensures that excavation at the three source areas (IRP Sites 1, 2 and 3) is controlled to prevent exposure to any residual contamination in the

subsurface soil; and prevent exposure to vapors that could accumulate in buildings effected by the contaminated groundwater plume.

OU-2/IRP Site 4

- The remedy at OU-2 continues to be protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

The protectiveness the landfill cap at IRP Site 4 been documented in the 1st and 2nd Five-Year Reviews and there have been no changes of any kind since 1997 that could affect the protectiveness of the remedy. A long-term inspection and maintenance program is in place to ensure continued protectiveness of the remedy.

OU-3/IRP Site 6

- The remedy at OU-3/IRP Site 6 is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

Construction of the remedy was completed in 2001 and a long-term inspection, maintenance and monitoring program is in place to ensue that the remedy remains in place as constructed. Current data indicates that natural flushing and natural attenuation are slowly reducing the size and strength of the contaminant plume within the compliance boundary and that groundwater quality is being met outside the compliance boundary. However, additional data/time is required to confirm that the revised/expanded Groundwater Compliance Boundary adequately defines where the dissolved arsenic is less than the 10 ug/L MCL. LUCs/ICs (whilst the remedy operates to meet the cleanup goals) prevent exposure to and use of contaminated groundwater and ensure that excavation at the three capped landfilled areas is controlled to prevent exposure to any residual contamination in the subsurface soil.

OU-3/IRP Site 21

- The remedy at OU-3/IRP Site 21 is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled.

Construction of the remedy was completed in 2003 and a long-term operation, maintenance and monitoring program is in place to ensue that the remedy remains in place as constructed. Current data indicates that the majority of the LNAPL was removed during the construction phase and that the residual contaminants at the site (dissolved-phase plume and LNAPL) are contained and are slowly decreasing due to natural attenuation, the ORC® application, and operation of the LNAPL/groundwater recovery system. Current data also indicates that that groundwater containing CoC concentrations exceeding ARARs is not discharging into the Shawsheen River.

LUCs/ICs (whilst the remedy operates to meet the cleanup goals) prevent exposure to and use of contaminated groundwater; ensures that excavation at the Site is controlled to prevent exposure to any residual contamination in the subsurface soil or groundwater; and that future land use does not increase the risk of exposure to contaminants remaining on site.

XI. Next Review

The next five-year review for the Hanscom Field/Hanscom AFB Superfund Site should be completed no later than five years following the signature date of this Five-Year Review Report which is anticipated to occur on or before September 30, 2007.

FIGURES

Figures

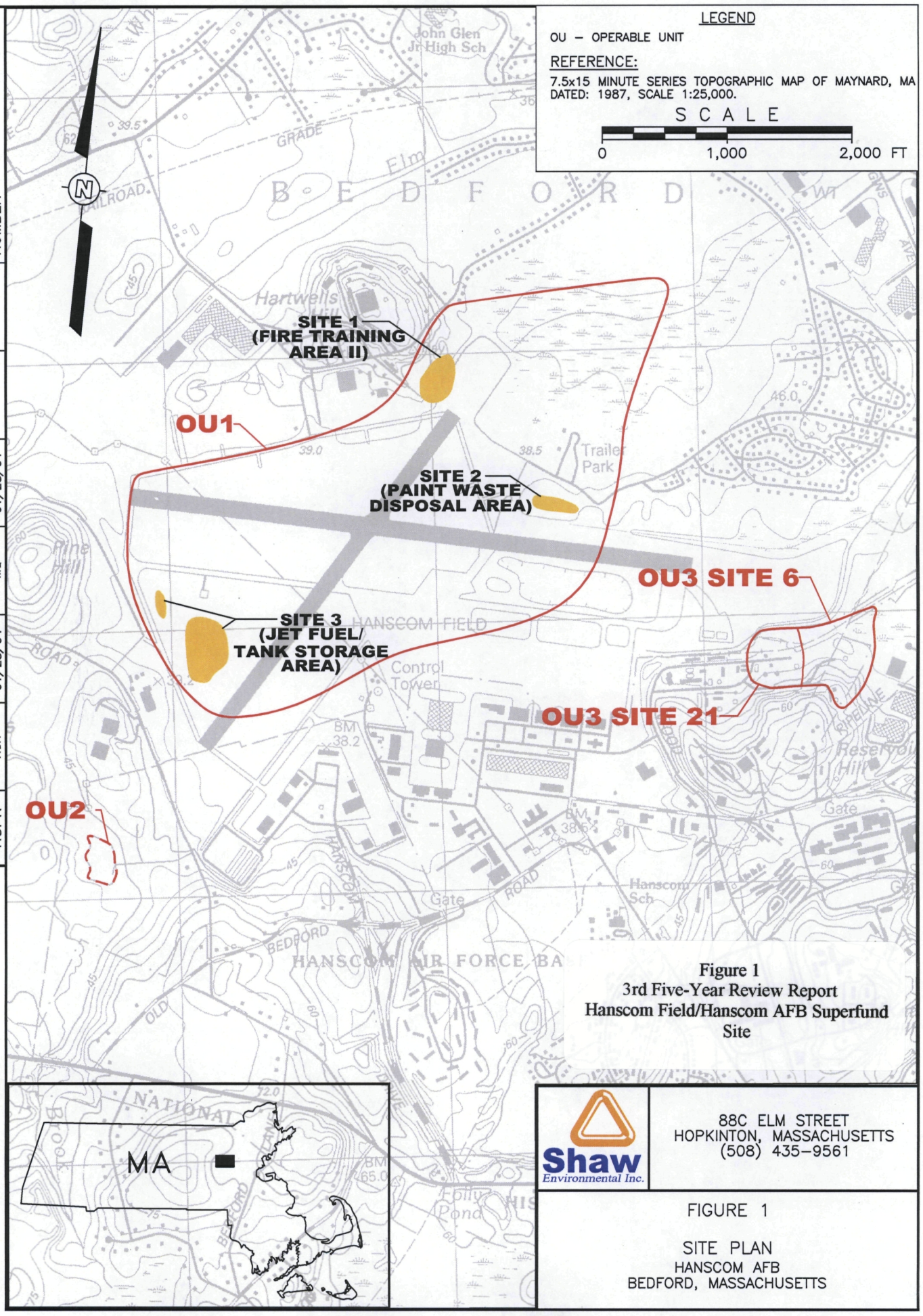


Figure 1
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund
Site

OFFICE	DRAW.	CHECKED BY	APPROVED BY	DRAWING NUMBER
HOPK	KCK 01/28/04	MQ 01/28/04		SITE9-2.dwg

File: N:\...nscom AFB\2004\OU1\SITE 9-3jb.dwg Layout: O.U. LOC FIG 1-1 User: chris.de ...14, 2007 - 4:30pm
XREF Fi...-2 IMAGE Files: maynard.tif

Shaw Environmental Inc.

88C ELM STREET
HOPKINTON, MASSACHUSETTS
(508) 435-9561

FIGURE 1

SITE PLAN
HANSCOM AFB
BEDFORD, MASSACHUSETTS

138808.FS.ZZ<Surfic>cac.wdc.04/00

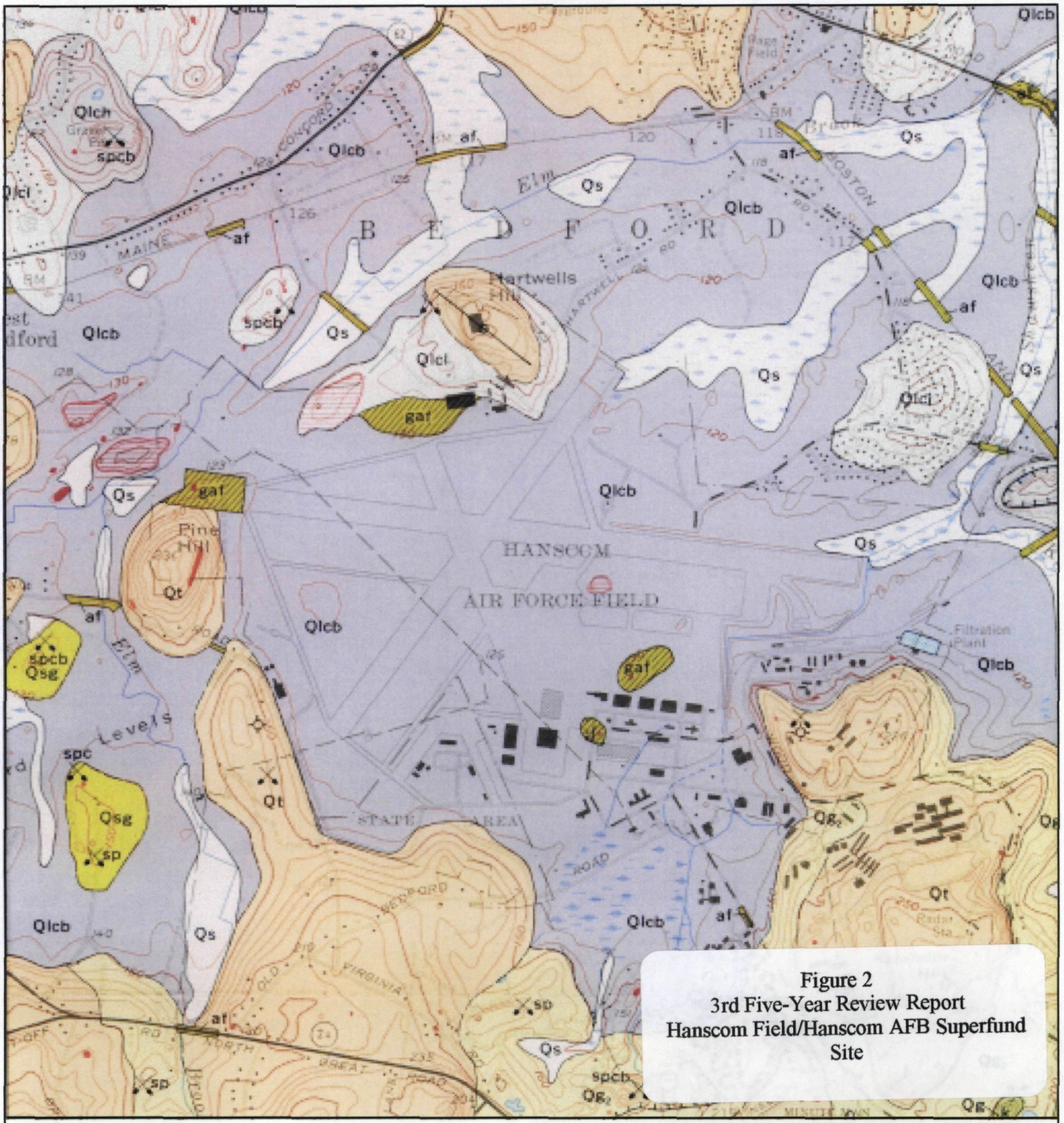


Figure 2
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

0 1 Mile

N

LEGEND

gaf	graded and filled	Qlcl	low stage lake deposits
Qg_2	sand, gravel, and silt	Qs	swamp deposits
Qlcb	lake bottom deposits	Qsg	sand and gravel
Qlch	high stage lake deposits	Qt	till

Source: U.S. Geological Survey Map GQ-331. Surficial Geology of the Concord Quadrangle. Carl Koteff, 1964.

Figure 8
SURFICAL GEOLOGY OF THE MODELED AREA
Hanscom Air Force Base
Operable Unit 1

CH2MHILL

MA DEP - Bureau of Waste Site Cleanup

Site Scoring Map: 500 feet & 0.5 Mile Radii

SITE NAME:
Site Scoring Map
...com AFB
313379n 217332ew

Site Location

The information shown on this map is the best available at the date of printing. Please refer to the data source descriptions document.

MASS GIS — Office of Geographic and Environmental Information
Massachusetts Executive Office of Energy & Environmental Affairs

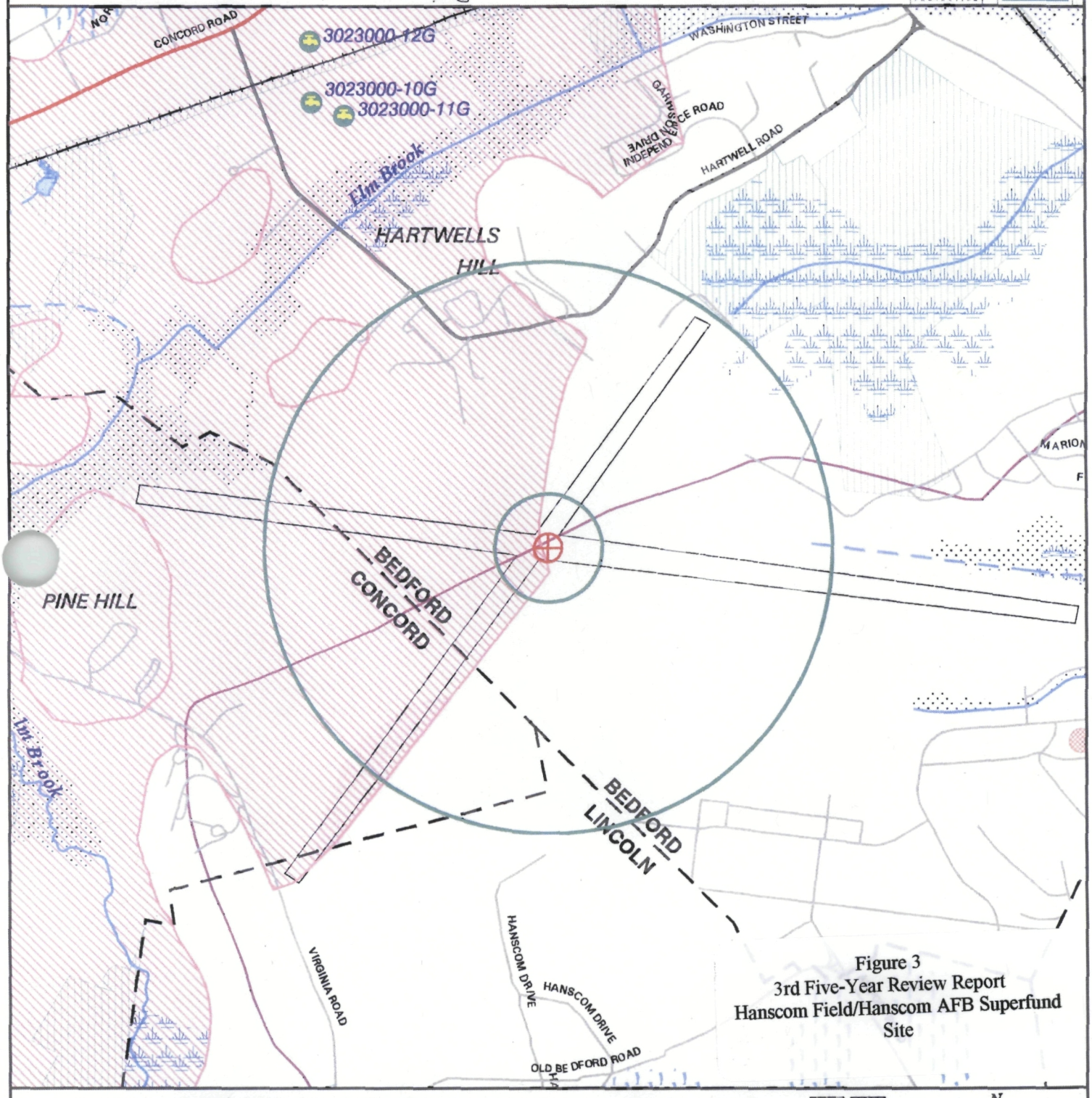


Figure 3
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

Roads: Limited Access, Divided, Major Road, Connector, Street, Track, Trail
Boundaries: Town, County, DEP Region; Train; Powerline; Pipeline; Aqueduct
Basins: Major, Sub; Streams: Perennial, Intermittent, Man Made Shore, Dams
Potentially Productive Aquifers: Medium, High Yield
Non-Potential Drinking Water Source Area: Medium, High Yield

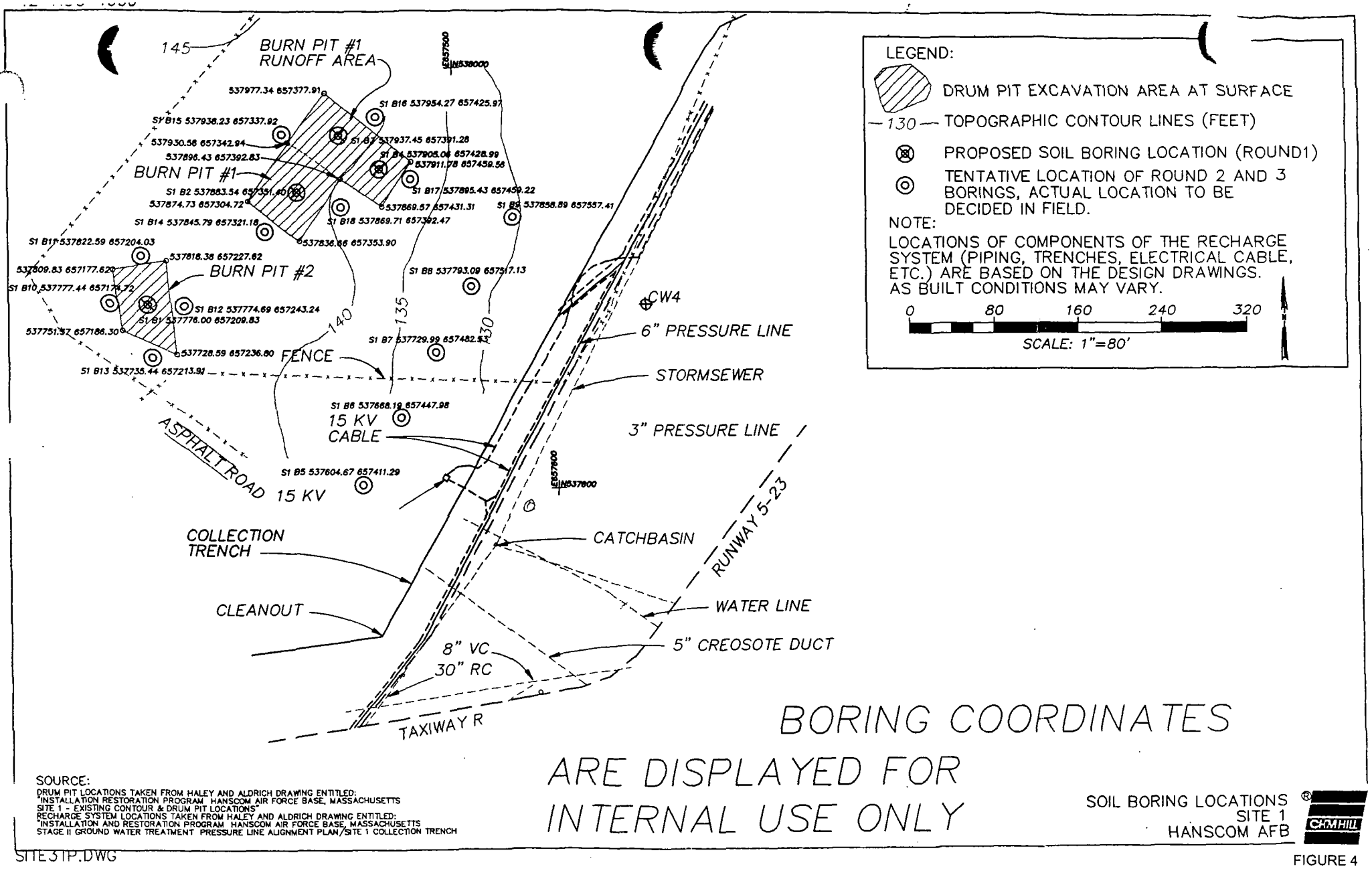
EPA Sole Source Aquifer; FEMA 100-year floodplain
Public Water Supplies: Ground, Surface, Non Community
Approved Zone2: IWPA; Surface Water Supply Zone A
Hydrography: Water Features, Public Surface Water Supply
Wetlands: Fresh, Salt, NHESP Wetlands Habitat
Protected Open Space; ACEC
DEP Permitted Solid Waste Facilities; Certified Vernal Pools

N NE E SE S SW W NW

SCALE 1:15000

0 1/2 1/2 MILES
0 1/2 1 KILOMETERS

June 20, 2007



BORING COORDINATES ARE DISPLAYED FOR INTERNAL USE ONLY

SOURCE:
DRUM PIT LOCATIONS TAKEN FROM HALEY AND ALDRICH DRAWING ENTITLED:
"INSTALLATION RESTORATION PROGRAM HANSCOM AIR FORCE BASE, MASSACHUSETTS
SITE 1 - EXISTING CONTOUR & DRUM PIT LOCATIONS"
RECHARGE SYSTEM LOCATIONS TAKEN FROM HALEY AND ALDRICH DRAWING ENTITLED:
"INSTALLATION AND RESTORATION PROGRAM HANSCOM AIR FORCE BASE, MASSACHUSETTS
STAGE II GROUND WATER TREATMENT PRESSURE LINE ALIGNMENT PLAN/SITE 1 COLLECTION TRENCH

SOIL BORING LOCATIONS
SITE 1
HANSCOM AFB

CH2MHILL

SITE3TP.DWG

FIGURE 4

Figure 4
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

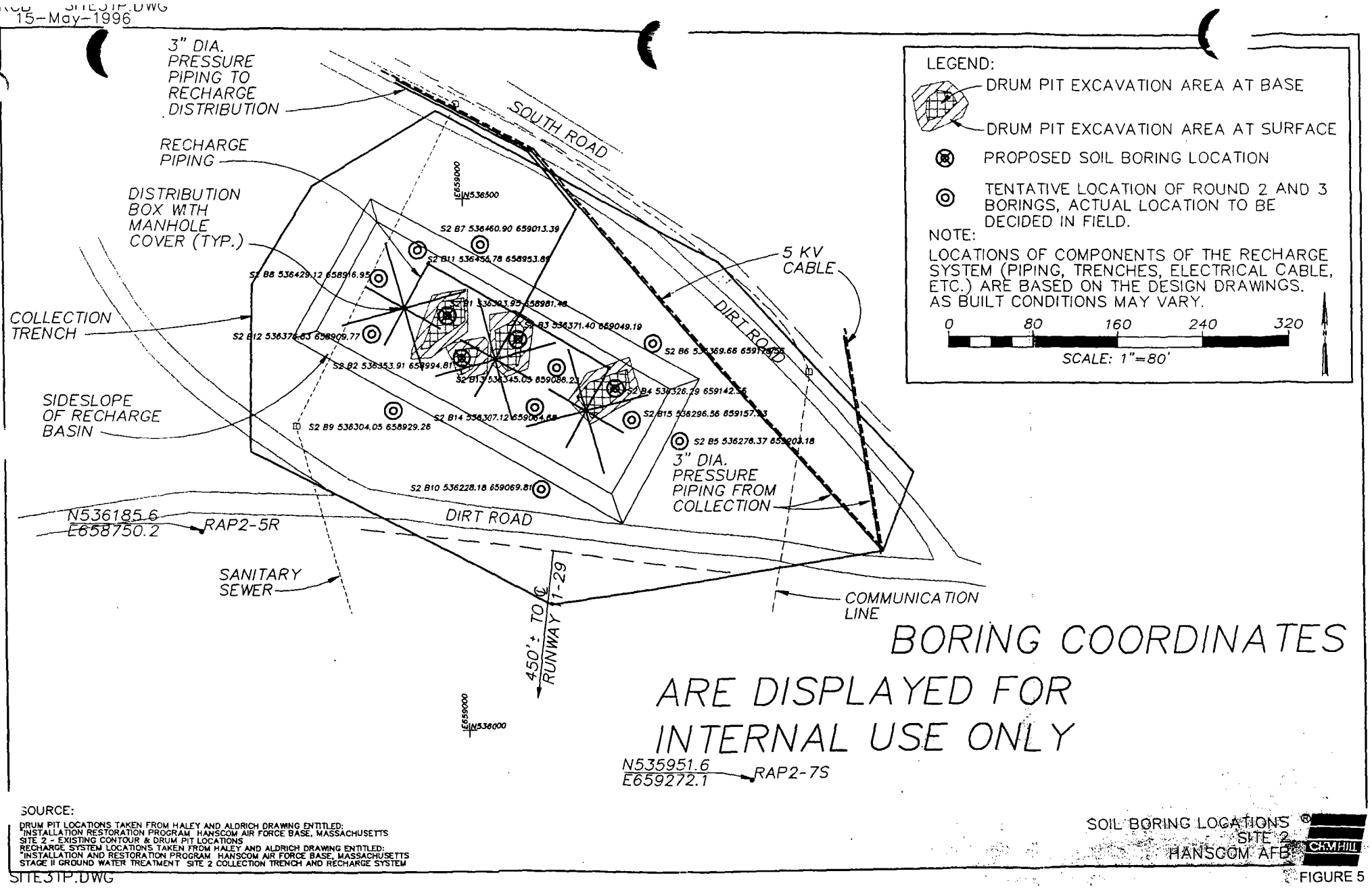
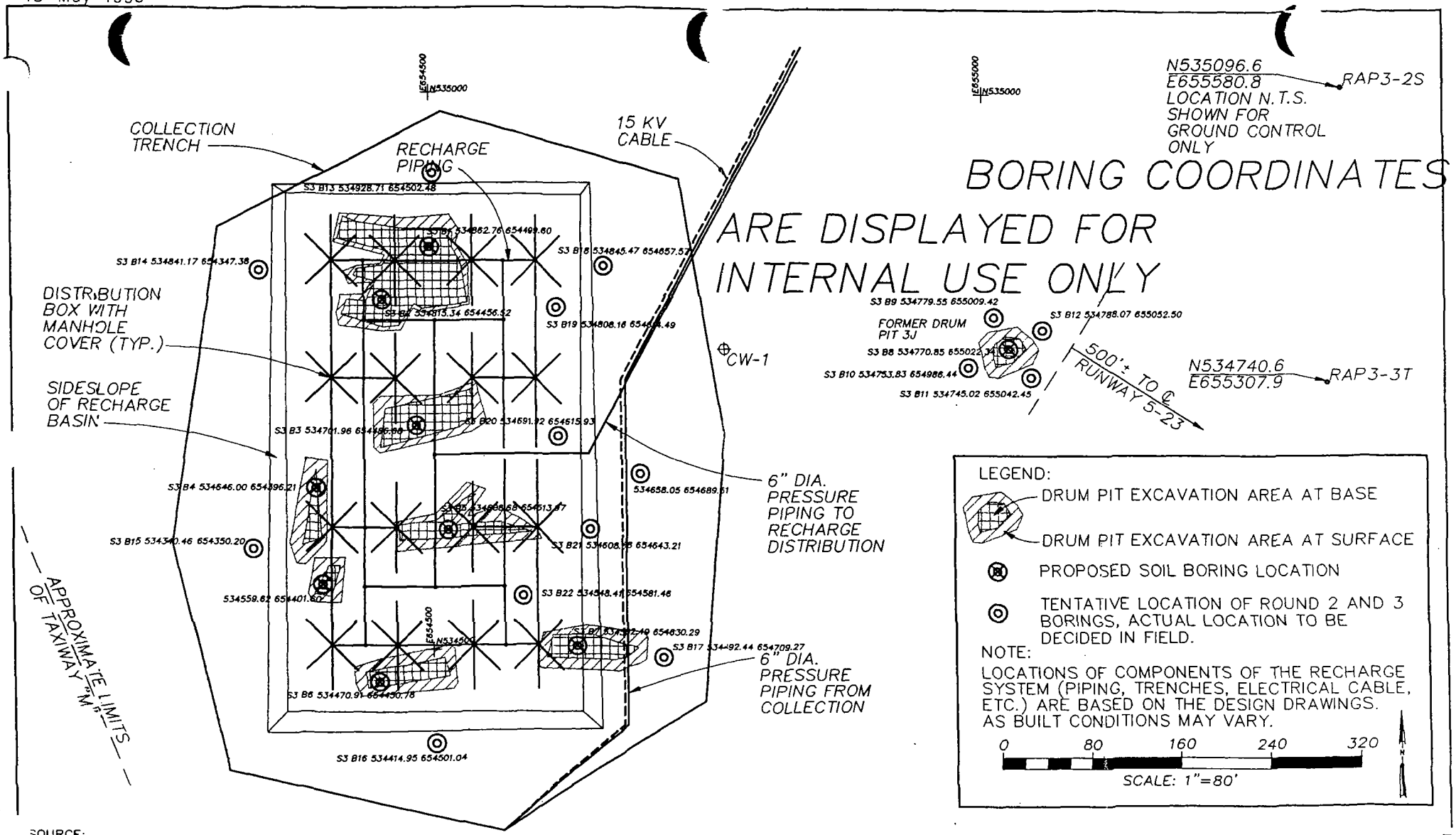


Figure 5
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

15-May-1996



SOURCE:
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SITE 3 - EXISTING CONTOUR & DRUM PIT LOCATIONS
RECHARGE SYSTEM LOCATIONS TAKEN FROM HALEY AND ALDRICH DRAWING ENTITLED:
"INSTALLATION AND RESTORATION PROGRAM HANSCOM AIR FORCE BASE, MASSACHUSETTS
STAGE II GROUND WATER TREATMENT SITE 3 COLLECTION TRENCH AND RECHARGE SYSTEM

SITE3TP.DWG

SOIL BORING LOCATIONS
SITE 3
HANSCOM AFB

CH2MHILL

FIGURE 6

Figure 6
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

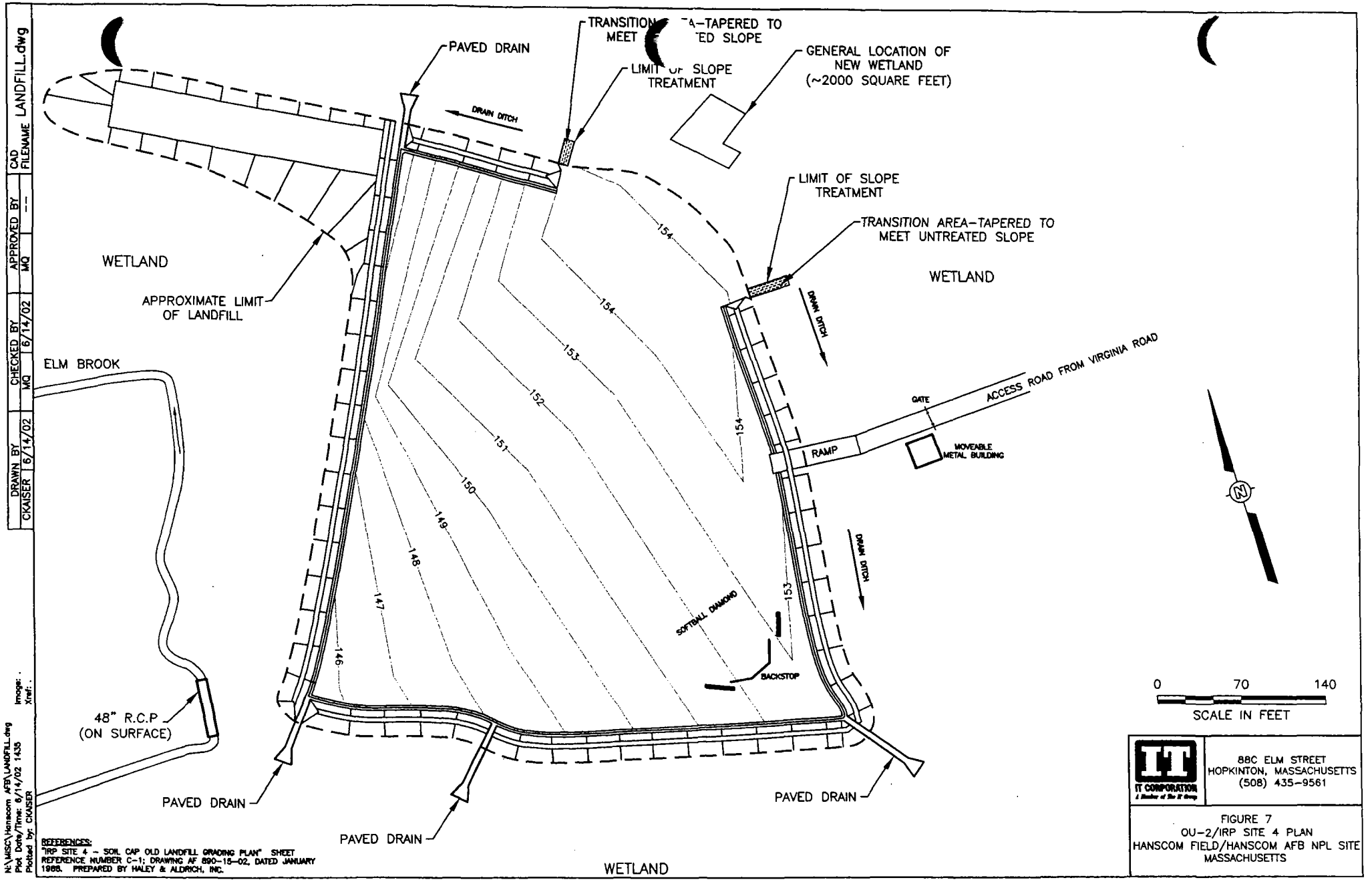


Figure 7
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund
Site

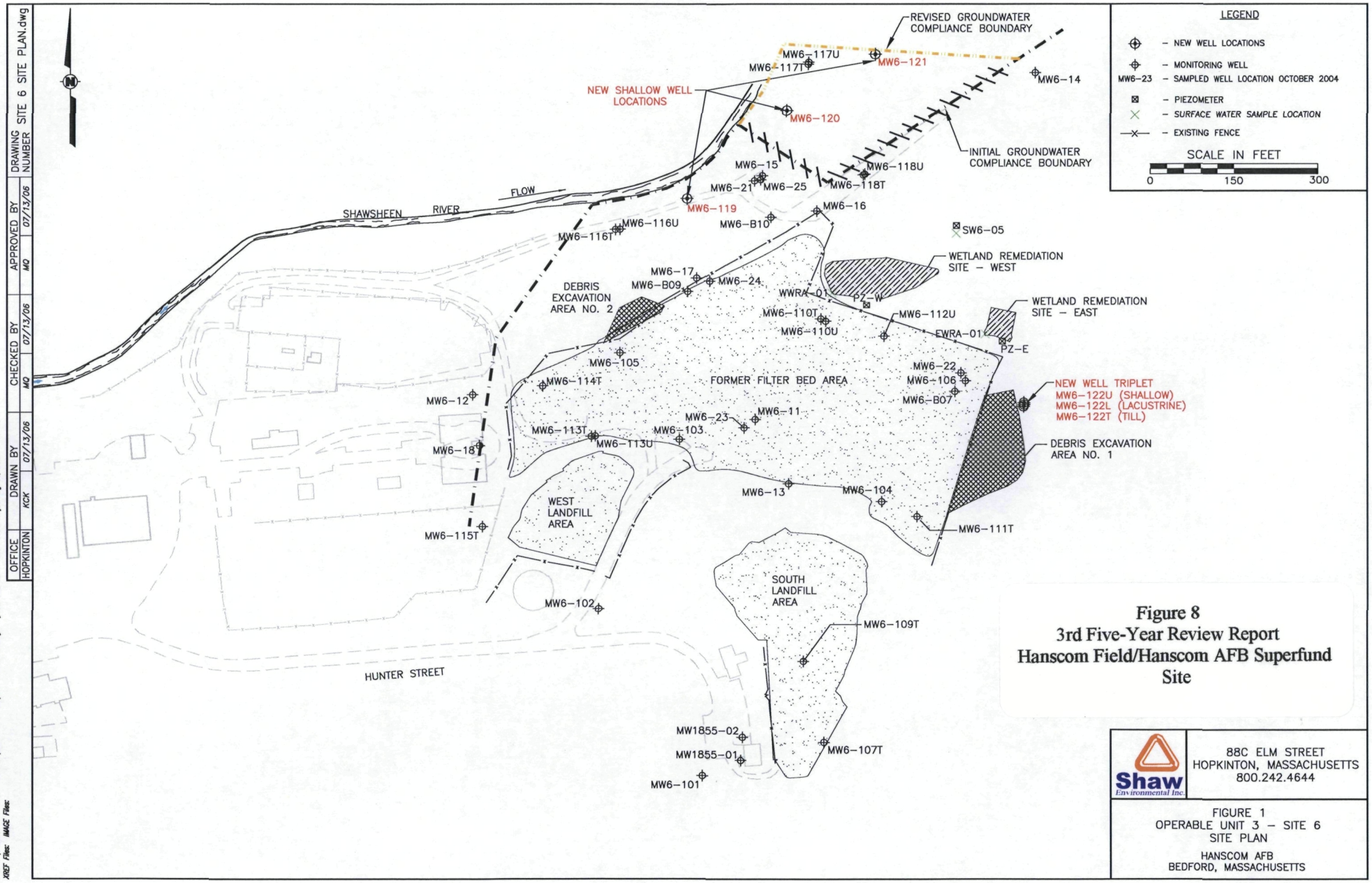


Figure 8
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

Shaw Environmental Inc.
88C ELM STREET
HOPKINTON, MASSACHUSETTS
800.242.4644

FIGURE 1
OPERABLE UNIT 3 – SITE 6
SITE PLAN
HANSCOM AFB
BEDFORD, MASSACHUSETTS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
HOPKINTON	KCK 07/13/06	MO 07/13/06	MO 07/13/06	SITE 6 SITE PLAN.dwg

File: O:\845802 – Hanscom–Marotech\Site 6 Site Plan\SITE 6 Site Plan.dwg Layout: SITE PLAN User: catherine.joe Aug 06, 2007 – 11:44am
XREF Files: IMAGE Files:

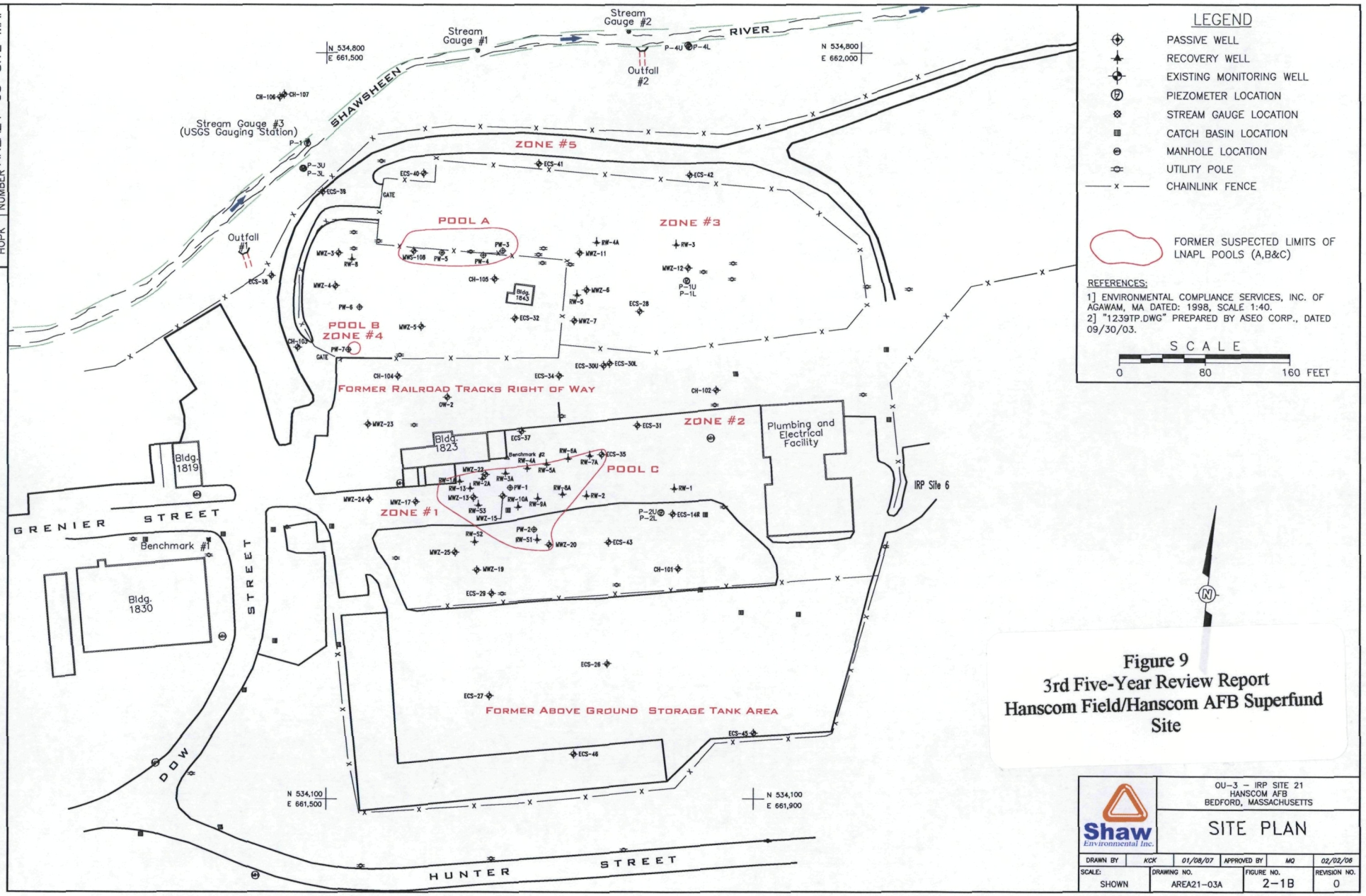


Figure 9
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

Shaw Environmental Inc.	OU-3 – IRP SITE 21 HANSCOM AFB BEDFORD, MASSACHUSETTS				
	SITE PLAN				
DRAWN BY	KCK	01/08/07	APPROVED BY	MQ	02/02/06
SCALE: SHOWN	DRAWING NO. AREA21-03A		FIGURE NO. 2-1B		REVISION NO. 0

Files: N:\MISC\Hanscom AFB\SITE21\AREA21-03-Site Map.dwg Layout: ENG User: catherine.joe Aug 06, 2007 - 11:29am
XREF Files: IMAGE Files:

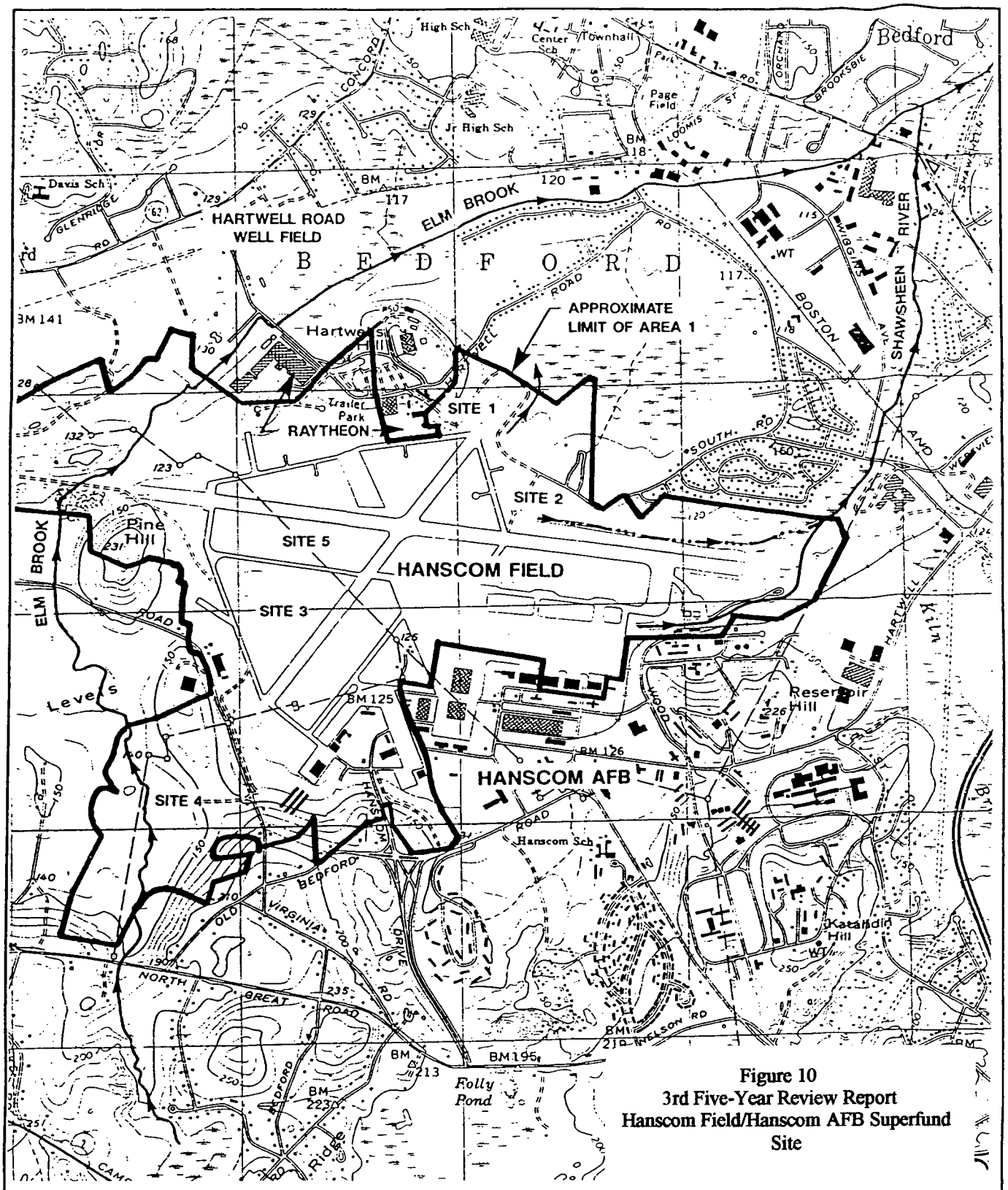
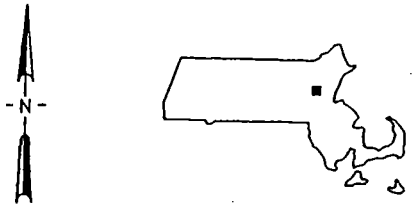


Figure 10
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

SITE COORDINATES: 42°28'08"N 71°17'33"W



U.S.G.S. QUADRANGLE: CONCORD, MA

HALEY & ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

LONG TERM SAMPLING PROGRAM
HANSCOM AIR FORCE BASE
BEDFORD, MASSACHUSETTS

PROJECT LOCUS

APPROXIMATE SCALE: 1:25,000

SEPTEMBER 1998

05833-065 A161

FIGURE 9

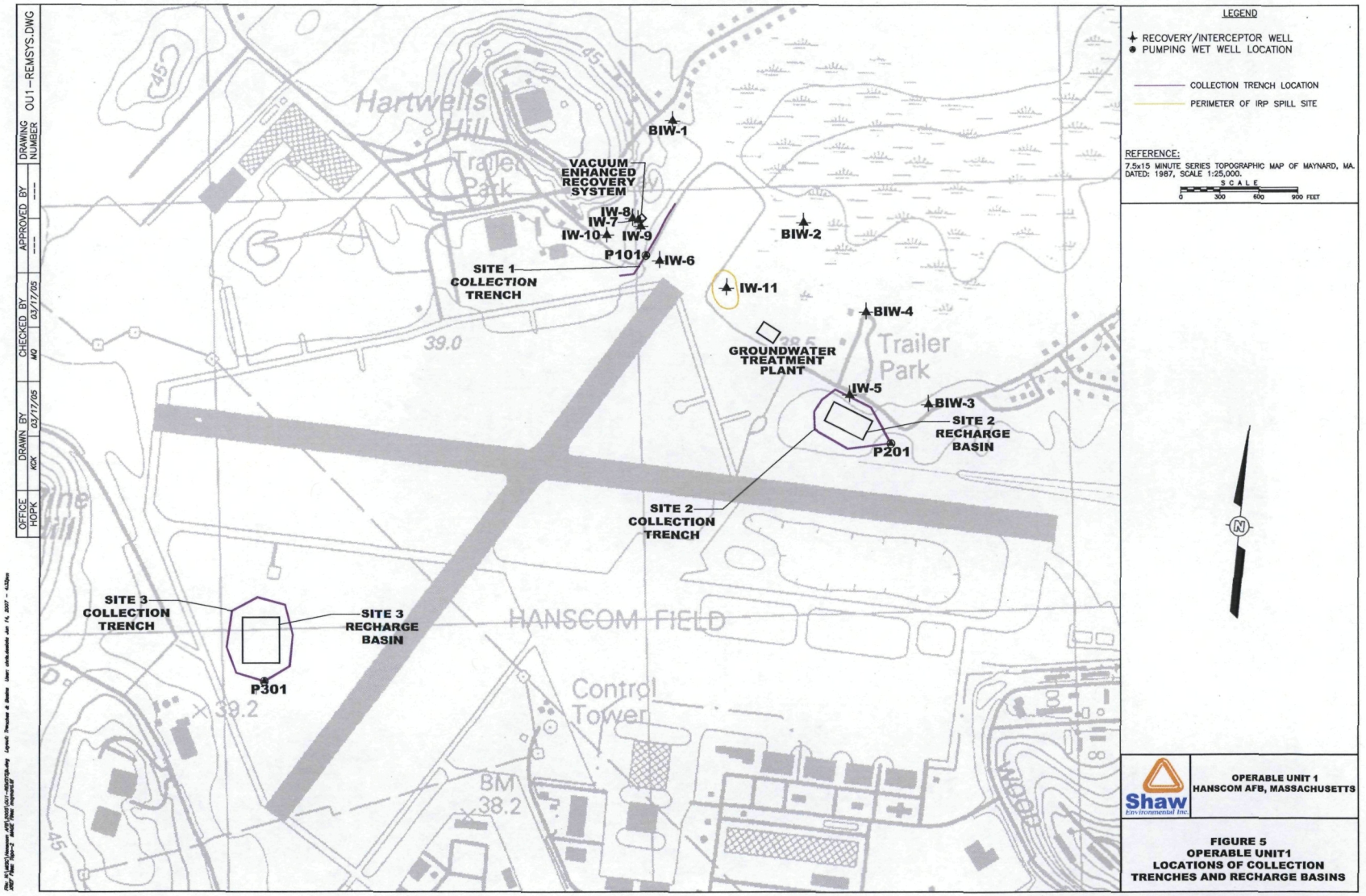


Figure 11
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

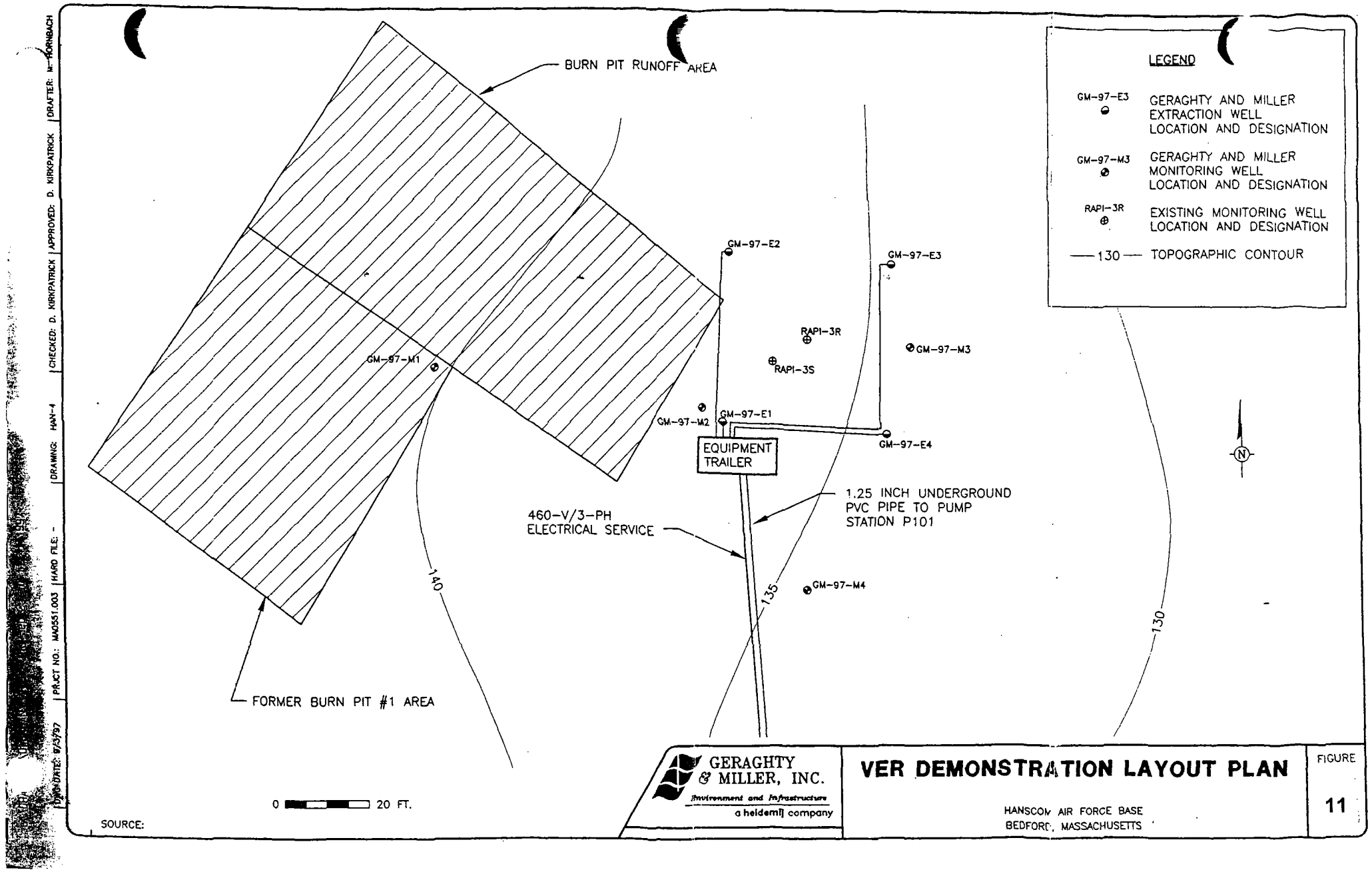


Figure 12
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

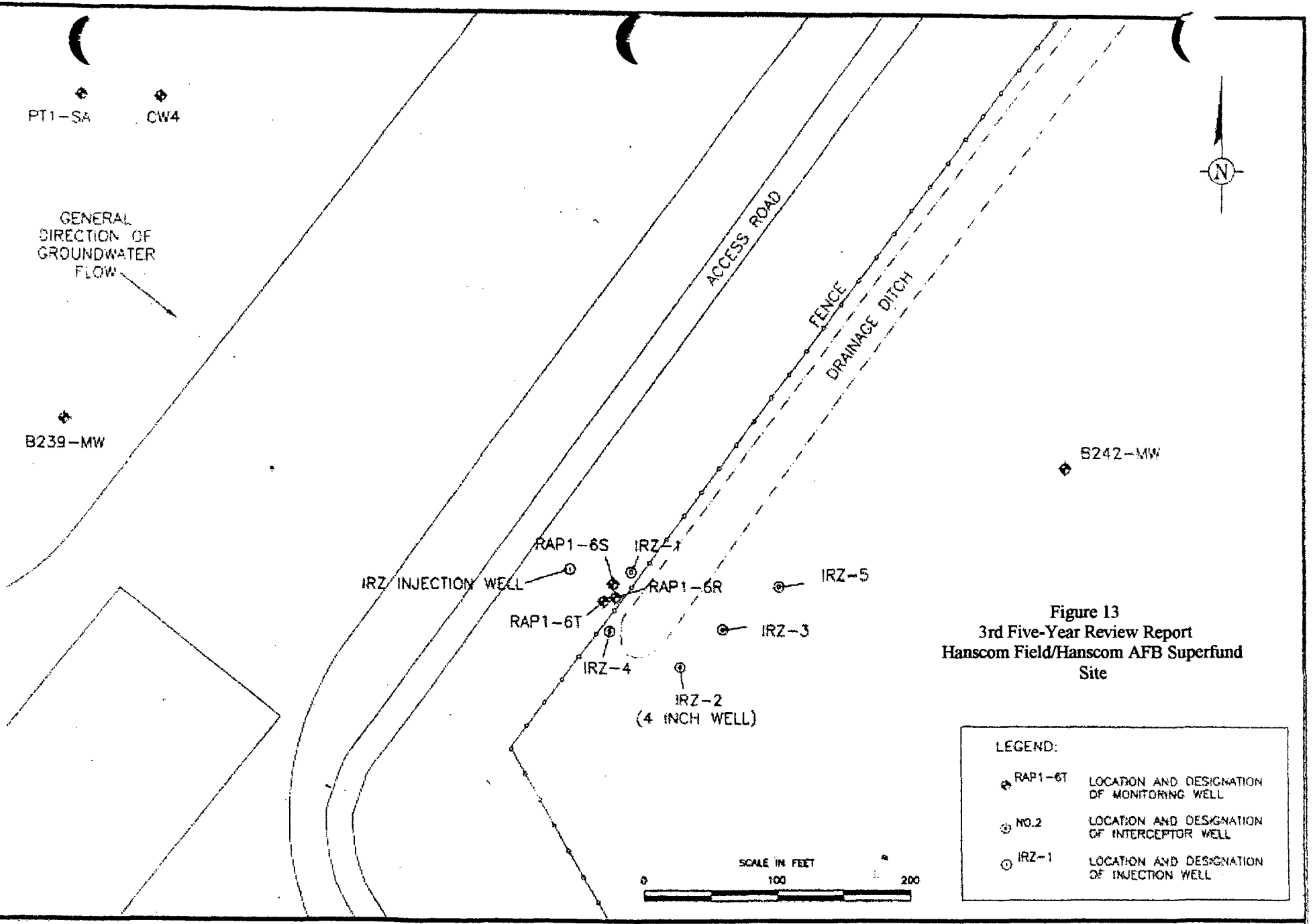


Figure 13
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

ARCADIS G&M
4915 Prospectus Drive
Suite F, DURHAM, NC 27713
Tel: 919/544-4535 Fax: 919/544-5690

SITE
LAYOUT
HANSCOM AFB
BEDFORD, MASSACHUSETTS

PROJECT MANAGER C. LUTES	DRAWING NUMBER PILOT-TEST-AREA
CHECKED BY V. D'AMATO	PROJECT NUMBER RNDOR001.0012.00001
DRAWN BY A. NORTON	FIGURE NUMBER 9
DATE DRAWN 20JUN01	

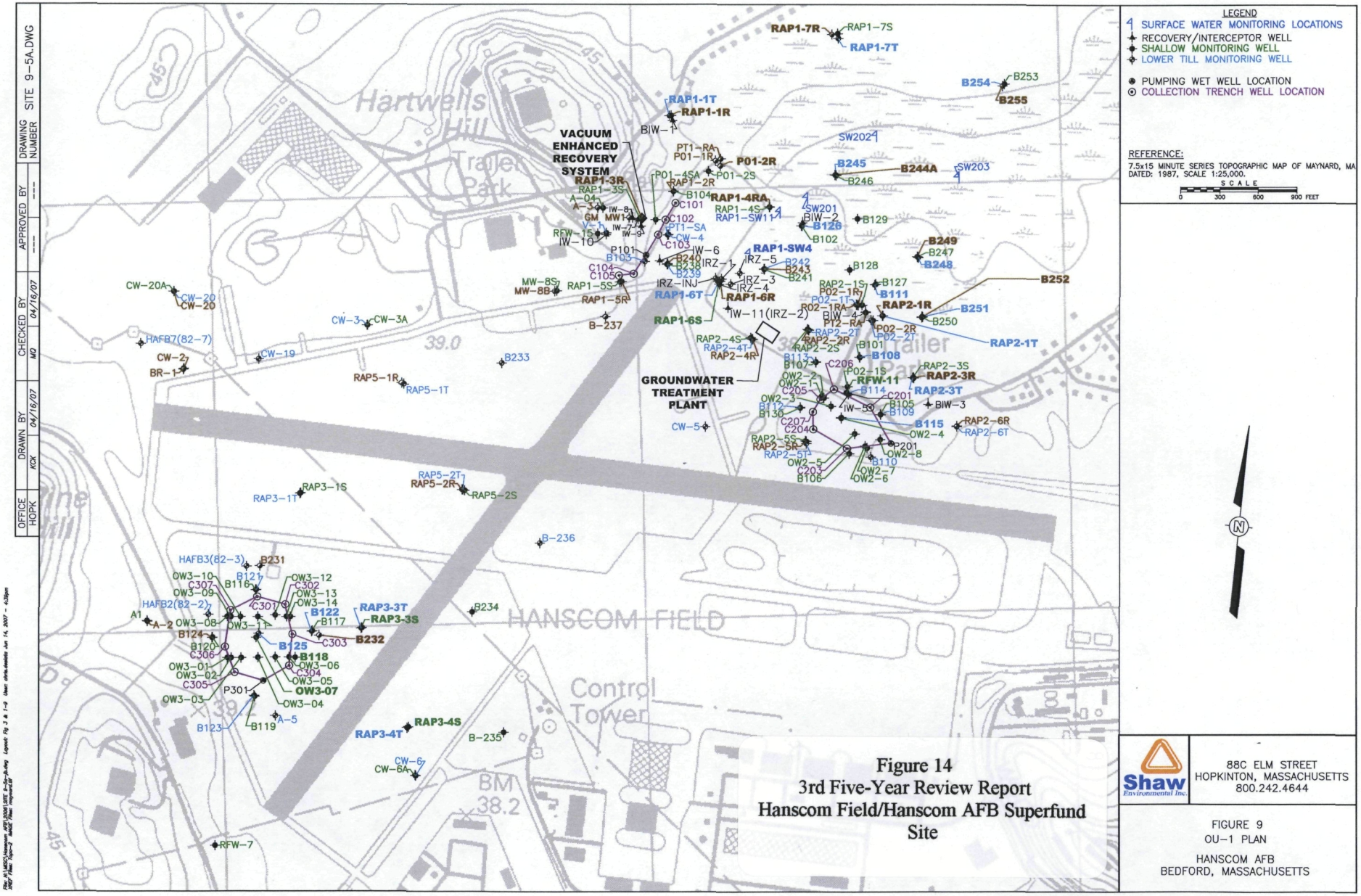


Figure 14
3rd Five-Year Review Report
Hanscom Field/Hanscom AFB Superfund Site

Shaw Environmental Inc.
88C ELM STREET
HOPKINTON, MASSACHUSETTS
800.242.4644

FIGURE 9
OU-1 PLAN
HANSCOM AFB
BEDFORD, MASSACHUSETTS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
HOPK	KCK 04/16/07	MD 04/16/07	--- ---	SITE 9-5A.DWG